

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

From the INTERNATIONAL BUREAU

To:

Commissioner
US Department of Commerce
United States Patent and Trademark
Office, PCT
2011 South Clark Place Room
CP2/5C24
Arlington, VA 22202
ETATS-UNIS D'AMERIQUE

in its capacity as elected Office

Date of mailing: 17 May 2001 (17.05.01)	
International application No.: PCT/IL00/00081	Applicant's or agent's file reference: PEI
International filing date: 07 February 2000 (07.02.00)	Priority date: 07 November 1999 (07.11.99)
Applicant: LANDA, Benzion et al	

1. The designated Office is hereby notified of its election made:

☒ in the demand filed with the International preliminary Examining Authority on:
31 October 2000 (31.10.00)☐ in a notice effecting later election filed with the International Bureau on:2. The election ☒ was☐ was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

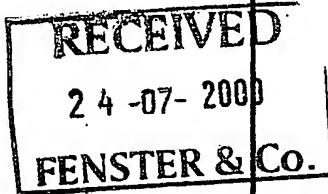
The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No.: (41-22) 740.14.35	Authorized officer: J. Zahra Telephone No.: (41-22) 338.83.38
---	---

PATENT COOPERATION TREATY

From the INTERNATIONAL SEARCHING AUTHORITY

PCT

To:
FENSTER & COMPANY PATENT
ATTORNEYS, LTD
Attn. FENSTER, P.
P.O.Box 10256
Petach Tikva 49002
ISRAEL



NOTIFICATION OF TRANSMITTAL OF
THE INTERNATIONAL SEARCH REPORT
OR THE DECLARATION

(PCT Rule 44.1)

Applicant's or agent's file reference PDY	Date of mailing (day/month/year) 19/07/2000
International application No. PCT/IL 99/ 00600	International filing date (day/month/year) 07/11/1999
Applicant INDIGO N.V. et al.	

1. ☒ The applicant is hereby notified that the International Search Report has been established and is transmitted herewith.

Filing of amendments and statement under Article 19:

The applicant is entitled, if he so wishes, to amend the claims of the International Application (see Rule 46):

When? The time limit for filing such amendments is normally 2 months from the date of transmittal of the International Search Report; however, for more details, see the notes on the accompanying sheet.

Where? Directly to the International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland
Facsimile No.: (41-22) 740.14.35

For more detailed instructions, see the notes on the accompanying sheet.

2. ☐ The applicant is hereby notified that no International Search Report will be established and that the declaration under Article 17(2)(a) to that effect is transmitted herewith.

3. ☐ With regard to the protest against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:

☐ the protest together with the decision thereon has been transmitted to the International Bureau together with the applicant's request to forward the texts of both the protest and the decision thereon to the designated Offices.

☐ no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

4. **Further action(s):** The applicant is reminded of the following:

Shortly after **18 months** from the priority date, the international application will be published by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the international Bureau as provided in Rules 50bis.1 and 50bis.5, respectively, before the completion of the technical preparations for international publication.

Within **19 months** from the priority date, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase until 30 months from the priority date (in some Offices even later).

Within **20 months** from the priority date, the applicant must perform the prescribed acts for entry into the national phase before all designated Offices which have not been elected in the demand or in a later election within 19 months from the priority date or could not be elected because they are not bound by Chapter II.

Name and mailing address of the International Searching Authority



European Patent Office, P.B. 5818 Patentlaan 2
NL-2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

Kenneth Ross

NOTES TO FORM PCT/ISA/220

These Notes are intended to give the basic instructions concerning the filing of amendments under article 19. The Notes are based on the requirements of the Patent Cooperation Treaty, the Regulations and the Administrative Instructions under that Treaty. In case of discrepancy between these Notes and those requirements, the latter are applicable. For more detailed information, see also the PCT Applicant's Guide, a publication of WIPO.

In these Notes, "Article", "Rule", and "Section" refer to the provisions of the PCT, the PCT Regulations and the PCT Administrative Instructions respectively.

INSTRUCTIONS CONCERNING AMENDMENTS UNDER ARTICLE 19

The applicant has, after having received the international search report, one opportunity to amend the claims of the international application. It should however be emphasized that, since all parts of the international application (claims, description and drawings) may be amended during the international preliminary examination procedure, there is usually no need to file amendments of the claims under Article 19 except where, e.g. the applicant wants the latter to be published for the purposes of provisional protection or has another reason for amending the claims before international publication. Furthermore, it should be emphasized that provisional protection is available in some States only.

What parts of the international application may be amended?

Under Article 19, only the claims may be amended.

During the international phase, the claims may also be amended (or further amended) under Article 34 before the International Preliminary Examining Authority. The description and drawings may only be amended under Article 34 before the International Examining Authority.

Upon entry into the national phase, all parts of the international application may be amended under Article 28 or, where applicable, Article 41.

When?

Within 2 months from the date of transmittal of the international search report or 16 months from the priority date, whichever time limit expires later. It should be noted, however, that the amendments will be considered as having been received on time if they are received by the International Bureau after the expiration of the applicable time limit but before the completion of the technical preparations for international publication (Rule 46.1).

Where not to file the amendments?

The amendments may only be filed with the International Bureau and not with the receiving Office or the International Searching Authority (Rule 46.2).

Where a demand for international preliminary examination has been/is filed, see below.

How?

Either by cancelling one or more entire claims, by adding one or more new claims or by amending the text of one or more of the claims as filed.

A replacement sheet must be submitted for each sheet of the claims which, on account of an amendment or amendments, differs from the sheet originally filed.

All the claims appearing on a replacement sheet must be numbered in Arabic numerals. Where a claim is cancelled, no renumbering of the other claims is required. In all cases where claims are renumbered, they must be renumbered consecutively (Administrative Instructions, Section 205(b)).

The amendments must be made in the language in which the international application is to be published.

What documents must/may accompany the amendments?

Letter (Section 205(b)):

The amendments must be submitted with a letter.

The letter will not be published with the international application and the amended claims. It should not be confused with the "Statement under Article 19(1)" (see below, under "Statement under Article 19(1)").

The letter must be in English or French, at the choice of the applicant. However, if the language of the international application is English, the letter must be in English; if the language of the international application is French, the letter must be in French.

NOTES TO FORM PCT/ISA/220 (continued)

The letter must indicate the differences between the claims as filed and the claims as amended. It must, in particular, indicate, in connection with each claim appearing in the international application (it being understood that identical indications concerning several claims may be grouped), whether

- (i) the claim is unchanged;
- (ii) the claim is cancelled;
- (iii) the claim is new;
- (iv) the claim replaces one or more claims as filed;
- (v) the claim is the result of the division of a claim as filed.

The following examples illustrate the manner in which amendments must be explained in the accompanying letter:

1. [Where originally there were 48 claims and after amendment of some claims there are 51]:
"Claims 1 to 29, 31, 32, 34, 35, 37 to 48 replaced by amended claims bearing the same numbers; claims 30, 33 and 36 unchanged; new claims 49 to 51 added."
2. [Where originally there were 15 claims and after amendment of all claims there are 11]:
"Claims 1 to 15 replaced by amended claims 1 to 11."
3. [Where originally there were 14 claims and the amendments consist in cancelling some claims and in adding new claims]:
"Claims 1 to 6 and 14 unchanged; claims 7 to 13 cancelled; new claims 15, 16 and 17 added." or
"Claims 7 to 13 cancelled; new claims 15, 16 and 17 added; all other claims unchanged."
4. [Where various kinds of amendments are made]:
"Claims 1-10 unchanged; claims 11 to 13, 18 and 19 cancelled; claims 14, 15 and 16 replaced by amended claim 14; claim 17 subdivided into amended claims 15, 16 and 17; new claims 20 and 21 added."

"Statement under article 19(1)" (Rule 46.4)

The amendments may be accompanied by a statement explaining the amendments and indicating any impact that such amendments might have on the description and the drawings (which cannot be amended under Article 19(1)).

The statement will be published with the international application and the amended claims.

It must be in the language in which the international application is to be published.

It must be brief, not exceeding 500 words if in English or if translated into English.

It should not be confused with and does not replace the letter indicating the differences between the claims as filed and as amended. It must be filed on a separate sheet and must be identified as such by a heading, preferably by using the words "Statement under Article 19(1)."

It may not contain any disparaging comments on the international search report or the relevance of citations contained in that report. Reference to citations, relevant to a given claim, contained in the international search report may be made only in connection with an amendment of that claim.

Consequence if a demand for international preliminary examination has already been filed

If, at the time of filing any amendments under Article 19, a demand for international preliminary examination has already been submitted, the applicant must preferably, at the same time of filing the amendments with the International Bureau, also file a copy of such amendments with the International Preliminary Examining Authority (see Rule 62.2(a), first sentence).

Consequence with regard to translation of the international application for entry into the national phase

The applicant's attention is drawn to the fact that, where upon entry into the national phase, a translation of the claims as amended under Article 19 may have to be furnished to the designated/elected Offices, instead of, or in addition to, the translation of the claims as filed.

For further details on the requirements of each designated/elected Office, see Volume II of the PCT Applicant's Guide.

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference PDY	FOR FURTHER ACTION see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
International application No. PCT/IL 99/ 00600	International filing date (day/month/year) 07/11/1999	(Earliest) Priority Date (day/month/year)
Applicant INDIGO N.V. et al.		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 3 sheets.
☒ It is also accompanied by a copy of each prior art document cited in this report.

1. Basis of the report

- a. With regard to the **language**, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.
- ☐ the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).
- b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :
- ☐ contained in the international application in written form.
 - ☐ filed together with the international application in computer readable form.
 - ☐ furnished subsequently to this Authority in written form.
 - ☐ furnished subsequently to this Authority in computer readable form.
 - ☐ the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
 - ☐ the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. ☐ **Certain claims were found unsearchable** (See Box I).

3. ☐ **Unity of invention is lacking** (see Box II).

4. With regard to the title,

- ☒ the text is approved as submitted by the applicant.
- ☐ the text has been established by this Authority to read as follows:

5. With regard to the abstract,

- ☒ the text is approved as submitted by the applicant.
- ☐ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the drawings to be published with the abstract is Figure No.

- ☒ as suggested by the applicant.
- ☐ because the applicant failed to suggest a figure.
- ☐ because this figure better characterizes the invention.
- 1 _____
☐ None of the figures.

INTERNATIONAL SEARCH REPORT

International Application No

PCT/IL 99/00600

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B41F21/12 B41F13/008

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 B41F B41J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 616 886 A (CUIR JEAN PIERRE ;CUIR GERARD (FR)) 28 September 1994 (1994-09-28)	1, 3, 24, 25, 30
Y	column 9, line 17 - line 47; figure 1	4-9, 11, 15, 17, 21, 31-33
X	EP 0 615 941 A (WARD HOLDING CO) 21 September 1994 (1994-09-21)	1, 3, 24, 25, 30
	column 1, line 13 - line 32 column 5, line 17 - line 46; figures 1-4	
Y	US 4 791 869 A (FURUKAWA) 20 December 1988 (1988-12-20)	4-9, 11, 15, 17, 21, 31-33
	the whole document	

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

- *A* document defining the general state of the art which is not considered to be of particular relevance
- *E* earlier document but published on or after the international filing date
- *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- *O* document referring to an oral disclosure, use, exhibition or other means
- *P* document published prior to the international filing date but later than the priority date claimed

- *T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- *X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- *Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- * & * document member of the same patent family

Date of the actual completion of the international search

11 July 2000

Date of mailing of the international search report

19/07/2000

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

DIAZ-MAROTO, V

INTERNATIONAL SEARCH REPORT

International Application No

PCT/IL 99/00600

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>EP-0 861 722 A (HEIDELBERGER DRUCKMASCH AG) 2 September 1998 (1998-09-02)</p> <p>-----</p>	

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/IL 99/00600

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
EP 0616886	A	28-09-1994	FR 2702998 A	30-09-1994
			CN 1099337 A	01-03-1995
			DE 69400007 D	27-07-1995
			DE 69400007 T	14-12-1995
			ES 2076845 T	01-11-1995
			US 5385091 A	31-01-1995
<hr/>				
EP 0615941	A	21-09-1994	US 5383392 A	24-01-1995
			DE 69406962 D	08-01-1998
			DE 69406962 T	09-04-1998
			US 5606913 A	04-03-1997
<hr/>				
US 4791869	A	20-12-1988	EP 0318605 A	07-06-1989
<hr/>				
EP 0861722	A	02-09-1998	DE 19707658 A	03-09-1998
			JP 10235842 A	08-09-1998
<hr/>				

INTERNATIONAL SEARCH REPORT

International Application No.

PCT/IL 00/00081

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 B41F21/10 B41F13/00 F16L39/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 B41F B41J F16L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

PAJ, EP0-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 196 35 388 A (KBA-PLANETA AG) 5 March 1998 (1998-03-05) the whole document ---	1
A	EP 0 312 660 A (KOMORI PRINTING MACHINERY CO. LTD.) 26 April 1989 (1989-04-26) column 8, line 29 - line 56; figures 3,4 ---	1
A	EP 0 311 924 A (KOENIG & BAUER AG) 19 April 1989 (1989-04-19) column 4, line 16 - column 5, line 28; figure 1 ---	1
A	EP 0 161 522 A (HEIDELBERGER DRUCKMASCHINEN AG.) 21 November 1985 (1985-11-21) page 6, line 8 - line 29; figure 1 ---	1
	-/--	

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

13 September 2000

Date of mailing of the international search report

29.09.00

Name and mailing address of the ISA

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Authorized officer

DIAZ-MAROTO, V

INTERNATIONAL SEARCH REPORT

Internal / Application No
PCT/IL 00/00081

C. (Continuation) - DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4 165 689 A (GIUIUZZA) 28 August 1979 (1979-08-28) the whole document ---	18
A	EP 0 435 164 A (M.A.N.-ROLAND DRUCKMASCHINEN AG.) 3 July 1991 (1991-07-03) the whole document ---	17,22
A	EP 0 570 786 A (KOENIG & BAUER AG) 24 November 1993 (1993-11-24) the whole document ---	17,22
A	EP 0 562 269 A (HEIDELBERGER DRUCKMASCHINEN AG.) 29 September 1993 (1993-09-29) column 14, line 32 - line 55; figures 9,10 ---	17,22
A	US 4 202 268 A (BECKER) 13 May 1980 (1980-05-13) ---	
A	FR 2 358 273 A (HEIDELBERGER DRUCKMASCHINEN AG.) 10 February 1978 (1978-02-10) -----	

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IL 00/00081

B x I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☒ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims: it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☒ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. Claims: 1-16

Apparatus for duplex printing

2. Claims: 18-21

A sheet transport system

3. Claims: 17, 22-32

A dynamic seal and an apparatus for transmitting vacuum

INTERNATIONAL SEARCH REPORT

Information on patent family members

Internat. Application No

PCT/IL 00/00081

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 19635388 A	05-03-1998	NONE	
EP 312660 A	26-04-1989	AT 68134 T US 4831929 A	15-10-1991 23-05-1989
EP 311924 A	19-04-1989	DE 3738674 A CS 8806737 A DD 282883 A DE 3886661 D JP 1123749 A JP 1898574 C JP 6024848 B US 4821643 A	20-04-1989 18-03-1992 26-09-1990 10-02-1994 16-05-1989 23-01-1995 06-04-1994 18-04-1989
EP 161522 A	21-11-1985	DE 3578402 D JP 60255434 A US 4621576 A	02-08-1990 17-12-1985 11-11-1986
US 4165689 A	28-08-1979	IT 1040008 B CA 1072815 A CH 605134 A DE 2633183 A FR 2318738 A GB 1548412 A JP 1355556 C JP 52034802 A JP 61025548 B SE 407184 B SE 7608189 A	20-12-1979 04-03-1980 29-09-1978 10-02-1977 18-02-1977 11-07-1979 24-12-1986 17-03-1977 16-06-1986 19-03-1979 25-01-1977
EP 435164 A	03-07-1991	DE 3943119 C AT 105236 T DE 59005621 D JP 1992227 C JP 6023941 A JP 7020696 B US 5110159 A	20-06-1991 15-05-1994 09-06-1994 22-11-1995 01-02-1994 08-03-1995 05-05-1992
EP 570786 A	24-11-1993	DE 4216306 A DE 59302146 D JP 7276604 A	18-11-1993 15-05-1996 24-10-1995
EP 562269 A	29-09-1993	DE 4210009 A AT 137168 T CN 1081142 A, B DE 59302314 D JP 6047893 A US 5439029 A	30-09-1993 15-05-1996 26-01-1994 30-05-1996 22-02-1994 08-08-1995
US 4202268 A	13-05-1980	DE 2358223 A AT 351052 B AT 789374 A CH 579460 A CS 186276 B DD 114554 A FR 2252216 A GB 1455756 A IT 1020758 B	28-05-1975 10-07-1979 15-12-1978 15-09-1976 30-11-1978 12-08-1975 20-06-1975 17-11-1976 30-12-1977

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/IL 00/00081

Patent document cited in search report	Publication date	Patent-family member(s)	Publication date
US 4202268 A		JP 951673 C	25-05-1979
		JP 50084312 A	08-07-1975
		JP 53031401 B	02-09-1978
		NL 7411933 A,B,	26-05-1975
		SE 407539 B	02-04-1979
		SE 7412964 A	23-05-1975
FR 2358273 A	10-02-1978	DE 2632243 A	26-01-1978
		AR 211419 A	15-12-1977
		AT 363495 B	10-08-1981
		AT 217777 A	15-01-1981
		AU 507745 B	28-02-1980
		AU 2364177 A	28-09-1978
		BE 856887 A	31-10-1977
		CA 1076620 A	29-04-1980
		CH 616620 A	15-04-1980
		CS 199668 B	31-07-1980
		DK 205177 A,B,	18-01-1978
		ES 459168 A	16-04-1978
		GB 1571935 A	23-07-1980
		HK 71280 A	02-01-1981
		IT 1083674 B	25-05-1985
		JP 1065751 C	30-09-1981
		JP 53011607 A	02-02-1978
		JP 56009426 B	02-03-1981
		NL 7703240 A,B,	19-01-1978
		NO 772523 A,B,	18-01-1978
		SE 414737 B	18-08-1980
		SE 7708295 A	18-01-1978
		US 4204471 A	27-05-1980
		ZA 7701436 A	22-02-1978

PATENT COOPERATION TREATY

RECEIVED

21-03-2002

FENSTER & Co.

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To:

Fenster Paul
FENSTER & COMPANY PATENT
ATTORNEYS, LTD
P.O.Box 10256
Petach Tikva 49002
ISRAEL

PCT

NOTIFICATION OF TRANSMITTAL OF
THE INTERNATIONAL PRELIMINARY
EXAMINATION REPORT
(PCT Rule 71.1)

Date of mailing
(day/month/year) 14.03.2002

Applicant's or agent's file reference
PEI

IMPORTANT NOTIFICATION

International application No.
PCT/IL00/00081

International filing date (day/month/year)
07/02/2000

Priority date (day/month/year)
07/11/1999

Applicant
INDIGO N.V. et al.

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.
2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.
3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

4. REMINDER

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

Name and mailing address of the IPEA/



European Patent Office
D-80298 Munich
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PCT



INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference PEI	FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/IL00/00081	International filing date (day/month/year) 07/02/2000	Priority date (day/month/year) 07/11/1999
International Patent Classification (IPC) or national classification and IPC B41F21/10		
Applicant INDIGO N.V. et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 6 sheets, including this cover sheet.
- ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).
- These annexes consist of a total of 5 sheets.

3. This report contains indications relating to the following items:
- I ☒ Basis of the report
 - II ☐ Priority
 - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
 - IV ☐ Lack of unity of invention
 - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
 - VI ☐ Certain documents cited
 - VII ☐ Certain defects in the international application
 - VIII ☐ Certain observations on the international application

Date of submission of the demand 31/10/2000	Date of completion of this report 14.03.2002
Name and mailing address of the international preliminary examining authority:  European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Fox, T Telephone No. +49 89 2399 2797 

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/IL00/00081

I. Basis of the report

1. With regard to the **elements** of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)*):

Description, pages:

1-23 as originally filed

Claims, No.:

1-28 with telefax of 04/03/2002

Drawings, sheets:

1/12-12/12 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/IL00/00081

☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-28
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-28
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1-28
	No:	Claims	

2. Citations and explanations
see separate sheet

V.

Claim 1:

The **closest prior art** is known from document EP-A-0 161 522 (D1) which discloses an apparatus for duplex printing wherein the perfector (15, Fig. 1) turns the sheet over and transfers the sheet to the second printing station. The perfector comprises only one gripping array for gripping the sheet at one edge. The apparatus according to claim 1 differs from the one according to D1 in that the perfector grips the sheet simultaneously along both the leading and trailing edges thereof.

The claimed apparatus is therefore new in the sense of Article 33(2) PCT.

The **object** of the present invention is to improve the accuracy with which the trailing edge of the sheet is registered to the leading edge of the sheet when printed on both sides.

This **object is achieved** by the above mentioned feature of claim 1 which distinguish the apparatus from the one known from D1.

None of the cited documents disclose or suggests such features.

The claimed apparatus involves therefore an inventive step in the sense of Article 33(3) PCT.

Claim 1 is not clear in the sense of Article 6 PCT, because the essential feature "the perfector rotates in a first direction when removing the sheet from a preceeding roller and rotates in an opposite direction when it passes of the sheet to a following transport element". Without this feature it is unclear how the perfector can turn over the sheet.

Claim 17:

The **closest prior art** is known from document US-A-4 202 268 (D2) which discloses a sheet transport system for a printer that receives a sheet from an impression roller of the printer on which a first side of the sheet is printed referenced to a leading edge of the sheet and if the sheet is to be printed on its second side, turns the sheet over and returns the sheet to the impression roller, comprising a perfector that removes a sheet form the impression roller after a first side of the sheet is printed and if a second side is not to be printed, moves the sheet towards a printer output tray, the perfector comprising:

first and second brackets independently rotatable about a same axis,
a plurality of suction cups mounted onto one bracket,

and at least one sheet support surface mounted on each bracket.

The apparatus according to claim 17 differs from the one according to D1 in that the sheet transport system comprises a conveyor belt that feeds the sheet placed thereon to the impression cylinder, in that the perfector places the sheet onto the conveyor belt if a second side of the sheet is to be printed, in that additional to the first bracket a plurality of suction cups are mounted onto the second bracket, and in that it is provided with a system that rotates the brackets sequentially, one after the other to remove printed sheets from the impression roller and either place a removed sheet on the conveyor or move the sheet towards the output tray.

The claimed apparatus is therefore new in the sense of Article 33(2) PCT.

The **object** of the present invention is to remove a sheet from an impression roller and to selectively transfer the sheet to an output tray or back to the impression roller.

This **object is achieved** by the two brackets which are independently rotatable about the same axis and which are rotated sequentially, one after the other to remove printed sheets from the impression roller and either place a removed sheet on the conveyor or move the sheet towards the output tray.

None of the cited documents disclose or suggests such features.

The claimed apparatus involves therefore an inventive step in the sense of Article 33(3) PCT.

The content of claim 21 goes beyond the disclosure in the international application as filed, because the only the brackets and not the whole perfector rotates in two different directions (see the embodiment according to Figs. 5a-5f). Consequently the requirements of Article 34 (2) (b) PCT are not met.

Claim 17 is not clear in the sense of Article 6 PCT, because the essential feature is missing that each bracket reverses its direction of rotation in order to turn over the sheet and to guide it for printing on its reverse side to the same impression roller.

Without this feature it is unclear how the perfector can turn over the sheet.

It is furthermore unclear, whether the impression roller mentioned in context with the conveyor belt is the same as the first impression roller or a different one.

Claim 22:

The **closest prior art** is known from document EP-A-0 435 164 (D3) which discloses an apparatus for transmitting vacuum to a device mounted on a rotating shaft. The

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT - SEPARATE SHEET**

International application No. PCT/IL00/00081

bearings are sealed with separated gaskets adjacent to the inner side of the bearings. The apparatus according to claim 22 differs from the one according to D3 in that bearings are grease sealed bearings wherein the grease acts as a vacuum seal for the cavity.

The claimed apparatus is therefore new in the sense of Article 33(2) PCT.

The **object** of the present invention is to improve the seal of an apparatus for transmitting vacuum to a device mounted on a rotating shaft.

This **object is achieved** by using the grease of the bearings as a vacuum seal, so that the construction of the apparatus is simplified and the additional gaskets as shown in D3 are not necessary.

None of the cited documents disclose or suggests such features. The claimed apparatus involves therefore an inventive step in the sense of Article 33(3) PCT.

Dependent claims

The dependent claims 2-16, 18-21, and 23-28 are directed to preferred embodiments of the subject matter of claims 1, 17 or 22 and likewise meet the requirements of Articles 33(2) and (3) PCT.

PEI A02

CLAIMS

1. Apparatus for duplex printing comprising:
a first impression roller on which a first side of a sheet having a leading edge and a
5 trailing edge is printed referenced to the leading edge;
a second impression roller on which a second side of the sheet is printed; and
a transport system that removes a printed sheet from the first impression roller and
transports it to the second impression roller, the transport system comprising a perfector
including an element rotating about an axis, the element receiving the sheet and gripping the
10 sheet simultaneously along both the leading and trailing edges thereof, which rotating element
turns the sheet over and transfers the sheet, trailing edge first, towards the second impression
roller.
2. Apparatus according to claim 1 wherein the perfector transfers the sheet with the
15 trailing edge registered to the leading edge.
3. Apparatus according to claim 1 or claim 2 wherein the perfector comprises a first
array of suction cups that grips the sheet adjacent the leading edge and a second array of
suction cups that grips the sheet adjacent the trailing edge.
20
4. Apparatus according to claim 3 wherein the distance between the first and second
suction cup arrays is adjustable to accommodate different size sheets.
5. Apparatus according to claim 3 or claim 4 wherein the perfector comprises a shaft to
25 which the arrays of suction cups are mounted.
6. Apparatus according to claim 5 wherein the first and second arrays of suction cups are
respectively connected via first and second internal channels in the shaft to at least one
vacuum system that controls aspiration of suction cups in the arrays.
30
7. Apparatus according to claim 6 wherein the first and second channels respectively
have first and second orifices on the surface of the shaft and wherein the first orifice is
displaced from the second orifice along the axis of the shaft.

PEI A02

8. Apparatus according to claim 7 and comprising first, second and third annular bearings mounted to the shaft, wherein each bearing has an inner and outer race that sandwiches a plurality of rollers and a grease seal providing a seal between the inner and outer race.

9. Apparatus according to claim 8 wherein the first orifice is located between the first and second bearings and the second orifice is located between the second and third bearings.

10. Apparatus according to claim 9 wherein the shaft is sealed to the inner race of each bearing.

11. Apparatus according to claim 10 and comprising a housing mounted on the bearings, the housing having a housing wall formed with first and second through holes and having a cavity defined by a cavity surface, and wherein the first through hole is located between the first and second bearings and the second through hole is located between the second and third bearings.

12. Apparatus according to claim 11 wherein the outer race of each bearing is sealed to the cavity wall.

13. Apparatus according to claim 12 wherein the first and second through holes are connected to the at least one vacuum system via first and second pressure hoses respectively and wherein the suction cups of the first and second suction cup arrays aspirate when the at least one vacuum system respectively draws air through the first and second pressure hoses.

14. Apparatus according to any of claims 1-13 wherein the perfecter comprises at least one sheet support surface on which the sheet lies when it is held by the perfecter.

15. Apparatus according to claim 14 and comprising a fan that creates airflow that presses the sheet flat to the at least one sheet support surface.

16. Apparatus according to any of the preceding claims wherein the perfecter rotates in a first direction when removing the sheet from a preceding roller and rotates in an opposite direction when it passes off the sheet to a following roller.

17. A sheet transport system for a printer that receives a sheet from an impression roller of the printer on which a first side of the sheet is printed referenced to a leading edge of the sheet and if the sheet is to be printed on its second side, turns the sheet over and returns the sheet to the impression roller, comprising:

5 a conveyor belt that feeds a sheet placed thereon to the impression roller;
a perfector that removes a sheet from the impression roller after a first side of the sheet is printed and if a second side of the sheet is to be printed, places the sheet on the conveyor belt, and if a second side is not to be printed, moves the sheet towards a printer output tray, the perfector comprising:

10 first and second brackets independently rotatable about a same axis;
a plurality of suction cups mounted on each of the first and second brackets;
at least one sheet support surface mounted on each bracket; and
a system that rotates the brackets sequentially, one after the other to remove printed sheets from the impression roller and either place a removed sheet on the conveyor or move
15 the sheet towards the output tray.

18. A sheet transport system according to claim 17 wherein the at least one support surface mounted on a bracket is a relatively long narrow surface defined by a plane curve whose plane is perpendicular to the axis about which the first and second brackets rotate and wherein the
20 radial distance from the axis to a point on the curve decreases as the distance of the point from the bracket increases.

19. A sheet transport system according to claim 18 wherein the at least one support surface of the first bracket is axially displaced from the at least one support surface of the second
25 bracket.

20. A sheet transport system according to any of claims 17-19 and comprising a fan that creates airflow that presses a sheet placed on the conveyor belt to the conveyor belt surface.

30 21. A sheet transport system according to any of claims 17-20 wherein the perfector rotates in a first direction when removing the sheet from a preceding roller and rotates in an opposite direction when it passes of the sheet to a following transport element.

PEI A02

22. An apparatus for transmitting vacuum to a device mounted on a rotating shaft comprising:

first and second annular bearings mounted to and sealed to the shaft so that there is a space between the bearings, wherein each bearing has an inner race and an outer race that sandwich a plurality of rollers and at least one seal between the inner and outer races;

a housing having a housing wall formed with a through hole, said housing wall together with said bearings forming a cavity that surrounds the shaft and communicates with said through hole, the housing wall being sealed to the outer race of each bearing;

wherein said shaft is formed with an internal channel having a first aperture that communicates with said cavity and a second aperture communicating with said device; and

wherein the bearings are grease sealed bearings and wherein the grease seal acts as a vacuum seal for the cavity.

23. Apparatus according to claim 22 and comprising a source of vacuum that communicates with the through hole to produce a vacuum in the cavity and thereby to transmit vacuum to the device.

24. Apparatus according to claim 23 and comprising a third grease sealed annular bearing that forms together with the second bearing and the housing wall an additional cavity that surrounds the shaft, wherein the bearing has an inner race and an outer race sealed to the shaft and housing respectively.

25. Apparatus according to claim 24 wherein the housing wall is formed with an additional through hole that communicates with the additional cavity.

26. Apparatus according to claim 25 wherein the shaft is formed with an additional internal channel that communicates with the additional cavity and with an additional device mounted to the shaft.

27. Apparatus according to claim 26 wherein the source of vacuum communicates with the through hole and the additional through hole to control vacuum in the cavity and the additional cavity independently of each other and thereby to independently control vacuum transmitted to the device and the additional device.

PEI A02

28. Apparatus according to any of claims 22-27 wherein at least one of the inner and outer races are seal to the shaft or housing by an o-ring seal.

PATENT COOPERATION TREATY

From the INTERNATIONAL SEARCHING AUTHORITY

PCT

To:

FENSTER & COMPANY PATENT
ATTORNEYS, LTD
Attn. Fenster Paul
P.O.Box 10256
Petach Tikva 49002
ISRAEL

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL SEARCH REPORT OR THE DECLARATION

(PCT Rule 44.1)

Date of mailing
(day/month/year)

29/09/2000

Applicant's or agent's file reference

PEI

FOR FURTHER ACTION

See paragraphs 1 and 4 below

International application No.

PCT/IL 00/00081

International filing date
(day/month/year)

07/02/2000

Applicant

INDIGO N.V. et al.

1. ☒ The applicant is hereby notified that the International Search Report has been established and is transmitted herewith.

Filing of amendments and statement under Article 19:

The applicant is entitled, if he so wishes, to amend the claims of the International Application (see Rule 46):

When? The time limit for filing such amendments is normally 2 months from the date of transmittal of the International Search Report; however, for more details, see the notes on the accompanying sheet.

Where? Directly to the International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland
Facsimile No.: (41-22) 740.14.35

For more detailed instructions, see the notes on the accompanying sheet.

2. ☐ The applicant is hereby notified that no International Search Report will be established and that the declaration under Article 17(2)(a) to that effect is transmitted herewith.

3. ☐ **With regard to the protest** against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:

☐ the protest together with the decision thereon has been transmitted to the International Bureau together with the applicant's request to forward the texts of both the protest and the decision thereon to the designated Offices.

☐ no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

4. **Further action(s):** The applicant is reminded of the following:

Shortly after **18 months** from the priority date, the international application will be published by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau as provided in Rules 90bis.1 and 90bis.3, respectively, before the completion of the technical preparations for international publication.

Within **19 months** from the priority date, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase until 30 months from the priority date (in some Offices even later).

Within **20 months** from the priority date, the applicant must perform the prescribed acts for entry into the national phase before all designated Offices which have not been elected in the demand or in a later election within 19 months from the priority date or could not be elected because they are not bound by Chapter II.

Name and mailing address of the International Searching Authority



European Patent Office, P.B. 5818 Patentlaan 2
NL-2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
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Authorized officer

Sophie Ruciak

NOTES TO FORM PCT/ISA/220

These Notes are intended to give the basic instructions concerning the filing of amendments under article 19. The Notes are based on the requirements of the Patent Cooperation Treaty, the Regulations and the Administrative Instructions under that Treaty. In case of discrepancy between these Notes and those requirements, the latter are applicable. For more detailed information, see also the PCT Applicant's Guide, a publication of WIPO.

In these Notes, "Article", "Rule", and "Section" refer to the provisions of the PCT, the PCT Regulations and the PCT Administrative Instructions, respectively.

INSTRUCTIONS CONCERNING AMENDMENTS UNDER ARTICLE 19

The applicant has, after having received the international search report, one opportunity to amend the claims of the international application. It should however be emphasized that, since all parts of the international application (claims, description and drawings) may be amended during the international preliminary examination procedure, there is usually no need to file amendments of the claims under Article 19 except where, e.g. the applicant wants the latter to be published for the purposes of provisional protection or has another reason for amending the claims before international publication. Furthermore, it should be emphasized that provisional protection is available in some States only.

What parts of the International application may be amended?

Under Article 19, only the claims may be amended.

During the international phase, the claims may also be amended (or further amended) under Article 34 before the International Preliminary Examining Authority. The description and drawings may only be amended under Article 34 before the International Examining Authority.

Upon entry into the national phase, all parts of the international application may be amended under Article 28 or, where applicable, Article 41.

When?

Within 2 months from the date of transmittal of the international search report or 16 months from the priority date, whichever time limit expires later. It should be noted, however, that the amendments will be considered as having been received on time if they are received by the International Bureau after the expiration of the applicable time limit but before the completion of the technical preparations for international publication (Rule 46.1).

Where not to file the amendments?

The amendments may only be filed with the International Bureau and not with the receiving Office or the International Searching Authority (Rule 46.2).

Where a demand for international preliminary examination has been/is filed, see below.

How?

Either by cancelling one or more entire claims, by adding one or more new claims or by amending the text of one or more of the claims as filed.

A replacement sheet must be submitted for each sheet of the claims which, on account of an amendment or amendments, differs from the sheet originally filed.

All the claims appearing on a replacement sheet must be numbered in Arabic numerals. Where a claim is cancelled, no renumbering of the other claims is required. In all cases where claims are renumbered, they must be renumbered consecutively (Administrative Instructions, Section 205(b)).

The amendments must be made in the language in which the international application is to be published.

What documents must/may accompany the amendments?

Letter (Section 205(b)):

The amendments must be submitted with a letter.

The letter will not be published with the international application and the amended claims. It should not be confused with the "Statement under Article 19(1)" (see below, under "Statement under Article 19(1)").

The letter must be in English or French, at the choice of the applicant. However, if the language of the international application is English, the letter must be in English; if the language of the international application is French, the letter must be in French.

NOTES TO FORM PCT/ISA/220 (continued)

The letter must indicate the differences between the claims as filed and the claims as amended. It must, in particular, indicate, in connection with each claim appearing in the international application (it being understood that identical indications concerning several claims may be grouped), whether

- (i) the claim is unchanged;
- (ii) the claim is cancelled;
- (iii) the claim is new;
- (iv) the claim replaces one or more claims as filed;
- (v) the claim is the result of the division of a claim as filed.

The following examples illustrate the manner in which amendments must be explained in the accompanying letter:

1. [Where originally there were 48 claims and after amendment of some claims there are 51]:
"Claims 1 to 29, 31, 32, 34, 35, 37 to 48 replaced by amended claims bearing the same numbers; claims 30, 33 and 36 unchanged; new claims 49 to 51 added."
2. [Where originally there were 15 claims and after amendment of all claims there are 11]:
"Claims 1 to 15 replaced by amended claims 1 to 11."
3. [Where originally there were 14 claims and the amendments consist in cancelling some claims and in adding new claims]:
"Claims 1 to 6 and 14 unchanged; claims 7 to 13 cancelled; new claims 15, 16 and 17 added." or
"Claims 7 to 13 cancelled; new claims 15, 16 and 17 added; all other claims unchanged."
4. [Where various kinds of amendments are made]:
"Claims 1-10 unchanged; claims 11 to 13, 18 and 19 cancelled; claims 14, 15 and 16 replaced by amended claim 14; claim 17 subdivided into amended claims 15, 16 and 17; new claims 20 and 21 added."

"Statement under article 19(1)" (Rule 46.4)

The amendments may be accompanied by a statement explaining the amendments and indicating any impact that such amendments might have on the description and the drawings (which cannot be amended under Article 19(1)).

The statement will be published with the international application and the amended claims.

It must be in the language in which the international application is to be published.

It must be brief, not exceeding 500 words if in English or if translated into English.

It should not be confused with and does not replace the letter indicating the differences between the claims as filed and as amended. It must be filed on a separate sheet and must be identified as such by a heading, preferably by using the words "Statement under Article 19(1)."

It may not contain any disparaging comments on the international search report or the relevance of citations contained in that report. Reference to citations, relevant to a given claim, contained in the international search report may be made only in connection with an amendment of that claim.

Consequence if a demand for international preliminary examination has already been filed

If, at the time of filing any amendments and any accompanying statement, under Article 19, a demand for international preliminary examination has already been submitted, the applicant must preferably, at the time of filing the amendments (and any statement) with the International Bureau, also file with the International Preliminary Examining Authority a copy of such amendments (and of any statement) and, where required, a translation of such amendments for the procedure before that Authority (see Rules 55.3(a) and 62.2, first sentence). For further information, see the Notes to the demand form (PCT/IPEA/401).

Consequence with regard to translation of the international application for entry into the national phase

The applicant's attention is drawn to the fact that, upon entry into the national phase, a translation of the claims as amended under Article 19 may have to be furnished to the designated/elected Offices, instead of, or in addition to, the translation of the claims as filed.

For further details on the requirements of each designated/elected Office, see Volume II of the PCT Applicant's Guide.

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference PEI	FOR FURTHER ACTION see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
International application No. PCT/IL 00/ 00081	International filing date (day/month/year) 07/02/2000	(Earliest) Priority Date (day/month/year) 07/11/1999
Applicant INDIGO N.V. et al.		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 6 sheets.



It is also accompanied by a copy of each prior art document cited in this report.

1. Basis of the report

- a. With regard to the **language**, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.



the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

- b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :



contained in the international application in written form.



filed together with the international application in computer readable form.



furnished subsequently to this Authority in written form.



furnished subsequently to this Authority in computer readable form.



the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.



the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. ☐ Certain claims were found unsearchable (See Box I).

3. ☒ Unity of invention is lacking (see Box II).

4. With regard to the title,



the text is approved as submitted by the applicant.



the text has been established by this Authority to read as follows:

5. With regard to the abstract,



the text is approved as submitted by the applicant.



the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the drawings to be published with the abstract is Figure No.



as suggested by the applicant.



because the applicant failed to suggest a figure.



because this figure better characterizes the invention.

1A



None of the figures.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/IL 00/00081

Box III TEXT OF THE ABSTRACT (Continuation of Item 5 of the first sheet)

Line 1: "...first impression roller (24)..."
Line 2: "...sheet (22)..."
Line 3: "...second impression roller (26)...system (20)"
Line 4: "...roller (24)..."
Line 5: "...roller (26)...perfector (32)..."

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IL 00/00081

Box I Observations where certain claims were found unsearchable (Continuation of Item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of Item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☒ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☒ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. Claims: 1-16

Apparatus for duplex printing

2. Claims: 18-21

A sheet transport system

3. Claims: 17, 22-32

A dynamic seal and an apparatus for transmitting vacuum

INTERNATIONAL SEARCH REPORT

International Application No.

IL 00/00081

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 B41F21/10 B41F13/00 F16L39/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 B41F B41J F16L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

PAJ, EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 196 35 388 A (KBA-PLANETA AG) 5 March 1998 (1998-03-05) the whole document ---	1
A	EP 0 312 660 A (KOMORI PRINTING MACHINERY CO. LTD.) 26 April 1989 (1989-04-26) column 8, line 29 - line 56; figures 3,4 ---	1
A	EP 0 311 924 A (KOENIG & BAUER AG) 19 April 1989 (1989-04-19) column 4, line 16 - column 5, line 28; figure 1 ---	1
A	EP 0 161 522 A (HEIDELBERGER DRUCKMASCHINEN AG.) 21 November 1985 (1985-11-21) page 6, line 8 - line 29; figure 1 --- -/--	1

☒ Further documents are listed in the continuation of box C.☒ Patent family members are listed in annex.

* Special categories of cited documents:

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

13 September 2000

Date of mailing of the international search report

29.09.00

Name and mailing address of the ISA

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INTERNATIONAL SEARCH REPORT

International Application No

/IL 00/00081

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4 165 689 A (GIUIUZZA) 28 August 1979 (1979-08-28) the whole document ----	18
A	EP 0 435 164 A (M.A.N.-ROLAND DRUCKMASCHINEN AG.) 3 July 1991 (1991-07-03) the whole document ----	17,22
A	EP 0 570 786 A (KOENIG & BAUER AG) 24 November 1993 (1993-11-24) the whole document ----	17,22
A	EP 0 562 269 A (HEIDELBERGER DRUCKMASCHINEN AG.) 29 September 1993 (1993-09-29) column 14, line 32 - line 55; figures 9,10 ----	17,22
A	US 4 202 268 A (BECKER) 13 May 1980 (1980-05-13) ----	
A	FR 2 358 273 A (HEIDELBERGER DRUCKMASCHINEN AG.) 10 February 1978 (1978-02-10) -----	

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

P L 00/00081

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
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EP 312660	A	26-04-1989	AT 68134 T US 4831929 A	15-10-1991 23-05-1989
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EP 161522	A	21-11-1985	DE 3578402 D JP 60255434 A US 4621576 A	02-08-1990 17-12-1985 11-11-1986
US 4165689	A	28-08-1979	IT 1040008 B CA 1072815 A CH 605134 A DE 2633183 A FR 2318738 A GB 1548412 A JP 1355556 C JP 52034802 A JP 61025548 B SE 407184 B SE 7608189 A	20-12-1979 04-03-1980 29-09-1978 10-02-1977 18-02-1977 11-07-1979 24-12-1986 17-03-1977 16-06-1986 19-03-1979 25-01-1977
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EP 562269	A	29-09-1993	DE 4210009 A AT 137168 T CN 1081142 A,B DE 59302314 D JP 6047893 A US 5439029 A	30-09-1993 15-05-1996 26-01-1994 30-05-1996 22-02-1994 08-08-1995
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PO L 00/00081

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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		ZA 7701436 A	22-02-1978

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference PEI	FOR FURTHER ACTION see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
International application No. PCT/IL 00/ 00081	International filing date (day/month/year) 07/02/2000	(Earliest) Priority Date (day/month/year) 07/11/1999
Applicant INDIGO N.V. et al.		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 6 sheets.
☒ It is also accompanied by a copy of each prior art document cited in this report.

1. Basis of the report

- a. With regard to the language, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.
- ☐ the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).
- b. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international search was carried out on the basis of the sequence listing :
- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. ☐ Certain claims were found unsearchable (See Box I).

3. ☒ Unity of invention is lacking (see Box II).

4. With regard to the title,

- ☒ the text is approved as submitted by the applicant.
- ☐ the text has been established by this Authority to read as follows:

5. With regard to the abstract,

- ☐ the text is approved as submitted by the applicant.
- ☒ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the drawings to be published with the abstract is Figure No.

- ☒ as suggested by the applicant.
- ☐ because the applicant failed to suggest a figure.
- ☐ because this figure better characterizes the invention.

1A
☐ None of the figures.

B x III TEXT OF THE ABSTRACT (Continuation of item 5 of the first sheet)

Line 1: "...first impression roller (24)..."

Line 2: "...sheet (22)..."

Line 3: "...second impression roller (26)...system (20)"

Line 4: "...roller (24)..."

Line 5: "...roller (26)...perfector (32)..."

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IL 00/00081

Box I Observations where certain claims were found unsearchable (Continuation of Item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☒ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☒ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. Claims: 1-16

Apparatus for duplex printing

2. Claims: 18-21

A sheet transport system

3. Claims: 17, 22-32

A dynamic seal and an apparatus for transmitting vacuum

INTERNATIONAL SEARCH REPORT

International Application No

PCT/IL 00/00081

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 B41F21/10 B41F13/00 F16L39/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 B41F B41J F16L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

PAJ, EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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A	EP 0 311 924 A (KOENIG & BAUER AG) 19 April 1989 (1989-04-19) column 4, line 16 -column 5, line 28; figure 1 ---	1
A	EP 0 161 522 A (HEIDELBERGER DRUCKMASCHINEN AG.) 21 November 1985 (1985-11-21) page 6, line 8 - line 29; figure 1 --- -/--	1



Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

* Special categories of cited documents :

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

13 September 2000

Date of mailing of the international search report

29.09.00

Name and mailing address of the ISA

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Authorized officer

DIAZ-MAROTO, V

INTERNATIONAL SEARCH REPORT

International Application No

PCT/IL 00/00081

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	EP 0 570 786 A (KOENIG & BAUER AG) 24 November 1993 (1993-11-24) the whole document ---	17,22
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A	US 4 202 268 A (BECKER) 13 May 1980 (1980-05-13) ---	
A	FR 2 358 273 A (HEIDELBERGER DRUCKMASCHINEN AG.) 10 February 1978 (1978-02-10) -----	

INTERNATIONAL SEARCH REPORT

Info on patent family members

International Application No

PCT/IL 00/00081

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
DE 19635388	A	05-03-1998	NONE	
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INTERNATIONAL SEARCH REPORT

Info on patent family members

International Application No

PCT/JP 00/00081

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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		AU 507745 B	28-02-1980
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		SE 7708295 A	18-01-1978
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<hr/>			

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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(72) Inventors; and

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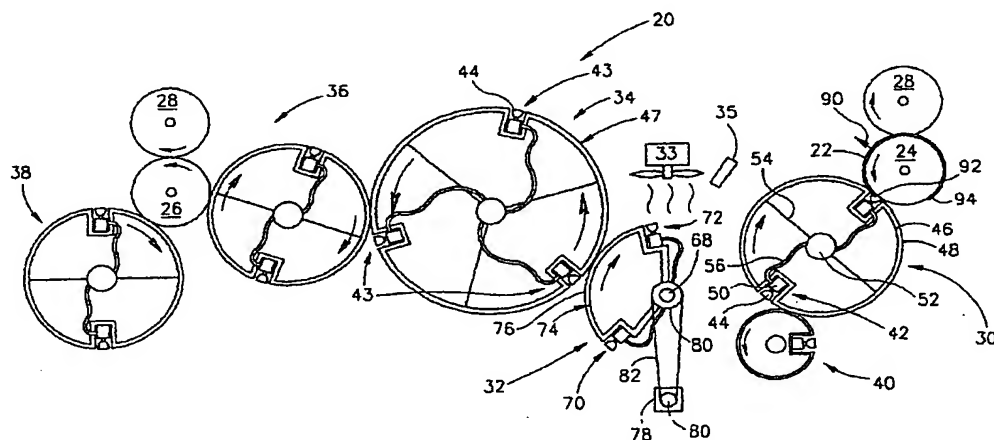
(74) Agents: **FENSTER, Paul et al.**; Fenster & Company
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Tikva (IL).

(81) Designated States (*national*): AE, AL, AM, AT, AU, AZ,
BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK,
DM, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL,
IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU,
LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT,
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MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM,
GA, GN, GW, ML, MR, NE, SN, TD, TG).

[Continued on next page]

(54) Title: DUPLEX PRINTING SYSTEM



(57) Abstract: Apparatus for duplex printing comprising: a first impression roller (24) on which a first side of a sheet (22) having a leading edge and a trailing edge is printed referenced to the leading edge; a second impression roller (26) on which a second side of the sheet is printed; and a transport system (20) that removes a printed sheet from the first impression roller (24) and transports it to the second impression roller (26), the transport system comprising a perceptor (32) that receives the sheet and grips it along both the leading and trailing edges of the sheet, which perceptor turns the sheet over and transfers the sheet trailing edge first towards the second impression roller.

WO 01/34396 A1

WO 01/34396 A1



Published:

— *With international search report.*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

DUPLEX PRINTING SYSTEM

FIELD OF THE INVENTION

The invention relates to printing systems and in particular to duplex printing systems for printing images on one or both sides of a sheet.

5 BACKGROUND OF THE INVENTION

Duplex printers and sheet transport systems for duplex printers that print both sides of a sheet and reference printing on each side of a sheet to a same edge of the sheet are known.

PCT application PCT/IL98/00553, which is incorporated herein by reference, describes a sheet transport system for a duplex printer that prints both sides of a sheet on a same impression roller. The publication also describes a sheet transport system for a tandem duplex printer that prints each sides of a sheet on a different impression roller.

The transport system, hereinafter referred to as a "re-feed transport system", for the printer that prints both sides of the sheet on a same impression roller receives a sheet from the impression roller after a first side of the sheet is printed. If the second side of the sheet is to be printed, it turns the sheet over and feeds it back to the impression roller for printing the second side. The position of the sheet on the impression roller when the sheet's second side is being printed is registered to the position of the sheet's leading edge. If the second side of the sheet is not to be printed, the transport system moves the sheet to an output tray.

The transport system comprises a sheet transporter and a conveyor belt. The sheet transporter, hereinafter referred to as a "perfector", operates to turn the sheet over and register the position of sheet on the impression roller to the leading edge of the sheet. The perfector comprises a first and second set of vacuum pick up arms. Each of the arms of the first set of arms is mounted to a same shaft and rotate with the shaft. Each of the arms of the second set of arms is mounted to an annulus that rotates about the shaft to which the arms of the first set of arm are attached. Each of the annuli is coupled by its own transmission belt to a drive shaft that rotates all the arms of the second set of arm together. The first and second sets of vacuum arms operate sequentially one after the other to repeatedly remove a printed sheet from the impression roller. When removing a sheet from the impression roller, a set of vacuum arms rotates in a direction opposite to the direction of rotation of the impression roller to a hand off position between the perfector and the impression roller. At the hand off position the set of vacuum arms grips the sheet by an edge of the sheet and rolls the sheet off the impression roller. If the sheet is printed on a first side, the edge that is gripped is a leading edge of the

sheet, to which edge printing on the first side is referenced. If the sheet being removed from impression roller is to be printed on its second side, the set of vacuum arms places the sheet, printed side face up, on the conveyor and reverses its direction of rotation. Motion of the conveyor belt and the reverse rotation of the set of vacuum arms feed the sheet back to the impression roller trailing edge first. The set of vacuum arms grips the leading edge of the sheet until a gripper on the impression roller grips the trailing edge and the sheet begins to roll up on the impression roller. As a result, the position of the sheet on the impression roller is registered to the leading edge of the sheet and printing of the second side of the sheet is referenced to the same leading edge to which printing on the first side of the sheet is registered.

PCT application PCT/IL99/00600 filed on 07-Nov-99 and entitled "Tandem Printing System with Fine Paper-Position Correction", describes a sheet transport system and a sheet fine position control system for a tandem printer that prints each side of a sheet on a different impression roller. The disclosure of the application is incorporated herein by reference. The described sheet "tandem" transport system described herein is similar to the tandem sheet transport system described in PCT application PCT/IL98/00553.

The transport system of this application transports a sheet from a first impression roller of the printer, on which a first side of the sheet is printed referenced to a leading edge of the sheet, to a second impression roller of the printer, on which a second side of the sheet is printed. The transport system registers a trailing edge of the sheet to the leading edge so that the position of the sheet on the second impression roller is registered with respect to the leading edge. Printing on the second side of the sheet is therefore referenced to the same leading edge to which printing on the first side of the sheet is referenced.

The sheet transport system comprises a plurality of rotating sheet transporters. Each transporter comprised in the transport system comprises a rotatable shaft and preferably at least one array of suction cups that are mounted to the shaft for gripping a sheet. The transporter also preferably comprises at least one surface, hereinafter referred to as a "support surface", for supporting a sheet that is gripped and held by the transporter's suction cups.

The transporters serially receive and hand off one to the other a sheet being transported by the transport system from the first impression to the second impression roller. A first transporter, hereinafter referred to as a "picker", functions to remove a sheet from the first impression roller. The picker grips a leading edge of the sheet that it removes from the

impression roller and hands off the leading edge to an adjacent transporter, hereinafter referred to as a "perfector". The perfector turns over the sheet that it receives and hands off a *trailing* edge of the sheet to a next transporter, hereinafter referred to as a "transfer transporter". The transfer transporter in turn hands off the trailing edge of the sheet to a feed roller that feeds the sheet to the second impression roller, which grips the sheet by the trailing edge.

In turning the sheet over, the perfector reverses its direction of rotation between clockwise and counterclockwise rotation and adjusts its speed of rotation so that when the trailing edge of the sheet is handed off to the transfer transporter, the trailing edge is registered to the leading edge. As a result, when the sheet is passed to the second impression roller, the sheet's position on the second impression roller is registered to the leading edge of the sheet, even though the second impression roller grips the sheet by the trailing edge of the sheet.

SUMMARY OF THE INVENTION

An aspect of some preferred embodiments of the present invention relates to providing an improved sheet transport system for a tandem printer that prints both sides of a sheet of a substrate with reference to a same edge of the sheet, wherein each side of the sheet is printed on a different impression roller.

An aspect of some preferred embodiments of the present invention relates to providing a "tandem" sheet transport system comprising an improved perfector.

A tandem sheet transport system, in accordance with a preferred embodiment of the present invention, is similar to the sheet transport system described in the above referenced PCT application PCT/IL99/00600. However, whereas the perfector described in PCT/IL99/00600 grips a sheet that it transports along the sheet's leading edge, a perfector in accordance with a preferred embodiment of the present invention grips a sheet that it transports along both its leading and trailing edges. The perfector preferably comprises two linear arrays of suction cups. One of the arrays grips a leading edge of a sheet that the perfector transports and the other grips the trailing edge of the sheet. The accuracy with which the trailing edge of the sheet is registered to the leading edge of the sheet is thereby improved.

According to an aspect of some preferred embodiments of the present invention, the position of at least one of the suction cup arrays is adjustable. As a result, the perfector and the transport system easily accommodate different size sheets. In some preferred embodiments of the present invention the position of least one suction cup array is manually adjustable. In

some preferred embodiments of the present invention controller controls an appropriate actuator or motor to adjust the position of at least one of the suction cup arrays.

According to an aspect of some preferred embodiments of the present invention a sheet transport system comprises at least one fan mounted over the perfector. The fan creates airflow that improves the accuracy of registration of a trailing edge of a sheet being transported by the sheet transport system to the sheet's leading edge.

When the picker in a sheet transport system, in accordance with a preferred embodiment of the present invention, hands off a sheet being transported by the transport system to the perfector a leading edge of the sheet is first gripped by a first suction cup array of the perfector. The sheet then rolls onto the at least one sheet support surface of the perfector and, when the trailing edge of the sheet rolls onto the at least one sheet support surface, the trailing edge is gripped by a second suction cup array of the perfector. In order for the trailing edge of the sheet to be properly aligned and registered to the leading edge it must lie flat on the at least one support surface. In accordance with a preferred embodiment of the present invention, as the sheet rolls onto the perfector's at least one support surface, the fan creates airflow that presses the sheet flat to the at least one support surface. As a result, the alignment of the trailing edge on the at least one support surface with respect to the position of the leading edge on the support surface is improved.

An aspect of some preferred embodiments of the present invention relates to providing an improved re-feed transport system for a duplex printer that prints both sides of a sheet on a same impression roller.

An aspect of some preferred embodiments of the present invention relates to providing a re-feed sheet transport system comprising an improved perfector.

A re-feed sheet transport system, in accordance with a preferred embodiment of the present invention, is similar to the re-feed sheet transport system described in the above referenced PCT application PCT/IL98/00553. The transport system comprises a perfector that removes sheets from the printer's impression roller and if the sheet is to be printed on a second side places the sheet on a conveyor that guides the sheet back to the impression roller. The perfector registers a trailing edge of the sheet to its leading edge so that the position of the sheet on the impression roller when the sheet's second side is being printed is registered to the sheet's leading edge. However, the transport system of the present application comprises a perfector having an improved construction.

A perfector in accordance with a preferred embodiment of the present invention comprises first and second interleaved rotary arms that rotate about a common axis of rotation. Each rotary arm, hereinafter referred to as a "pick and place" arm, preferably comprises a linear array of suction cups and at least one support surface. The first and second pick and place arms operate to remove sheets from the impression roller after they are printed similarly to the way in which the first and second sets of vacuum pick-up arms of the perfector described in PCT application PCT/IL98/00553 operate.

Each pick and place arm rotates to a pick off position between the perfector and the impression roller at which position it grips an edge of a sheet being printed. If a sheet removed by a pick and place does not require printing on a second side, the pick and place hands off the sheet to an adjacent transporter that moves the sheet towards an output tray. If the sheet requires printing on a second side, the edge of the sheet that the pick and place grips at the pick off position is a leading edge of the sheet and the pick and place places the sheet on the moving conveyor belt, printed surface face up. The pick and place arm then reverses its direction of rotation and together with the conveyor belt guides the sheet back to the impression roller, trailing edge first, for printing on the second side. The pick and place arm does not release the leading edge until the impression roller grips the trailing edge. The pick and place thereby maintains registration of the trailing edge of the sheet to the leading edge of the sheet. The pick and place arms operate sequentially one after the other to repeatedly pick a printed sheet off the impression roller and place it on the conveyor or hand it off towards the output tray.

When a pick and place removes a sheet from the impression roller, in accordance with a preferred embodiment of the present invention, the sheet rolls off the impression roller and onto the at least one support surface of the pick and place. The at least one support surface contributes to a smooth roll off of the sheet from impression roller and to reducing fluctuations in a force with which the pick and place arm pulls the sheet off the impression roller. The at least one support surface substantially reduces damage to the sheet from kinking or wrinkling of the sheet in regions near to suction cups of the pick and place.

According to an aspect of some preferred embodiments of the present invention a re-feed sheet transport system comprises at least one fan positioned to create airflow that presses the sheet flat to the conveyor belt surface. By pressing the sheet flat to the surface of the

conveyor the accuracy with which the trailing edge of the sheet is registered to the leading edge of the sheet is improved.

Proper operation of an transport system in accordance with a preferred embodiment of the present invention requires controlling suction cups on the various transporters so that they
5 suck and release air at appropriate times. The suction cups, which are mounted to rapidly rotating shafts, must therefore be connected to appropriate vacuum pumps and valves.

Methods for transmitting pressure or vacuum to devices mounted to a rotating shaft are known in the art. The devices are connected to appropriate channels in the shaft which in turn are connected to desired vacuum pumps, pressure pumps and valves, hereinafter referred to
10 collectively or individually as "pressure devices".

If one or two channels are needed, a channel is formed at one end or at both ends of the shaft and the end or ends of the shaft are connected to a desired pressure device by a rotary joint. If more than two channels are needed, or more than one channel is needed at a same end of the shaft, in accordance with a preferred embodiment of the present invention, a sealed
15 cavity is formed about the shaft for each channel required. The shaft passes through walls that form the cavity, which are sealed to the shaft using dynamic seals. The dynamic seals allow the shaft to rotate while supporting a pressure differential between one side and the other side of each of the cavity walls through which the shaft passes. The channel is connected to the cavity via a hole that leads from the channel and exits the shaft in a surface region of the shaft
20 located inside the cavity. Pressure or vacuum generated in the cavity is transmitted through the hole to the channel and from the channel to devices connected to the channel. Dynamic seals, such as those known in the prior art generally exert large torque on shafts to which they are coupled and often substantially increase the rate of wear of the shafts. This makes them unsuitable for use in printing systems.

25 An aspect of some preferred embodiments of the present invention relates to providing dynamic seals that exert relatively small torque on shafts to which they are coupled and which do not substantially accelerate wear of the shafts.

In accordance with a preferred embodiment of the present invention a dynamic seal is formed between a rotatable shaft and a wall of a sealed cavity through which the shaft passes
30 by a rotary bearing that couples the shaft to the wall. An inner race of the bearing presses on a seal, preferably an o-ring seal, mounted on the shaft and an outer race of the bearing presses on a similar seal mounted in the wall. The seals between the outer and inner races of the bearing

that protect the bearing's rollers from dirt, and the o-ring seals between the bearing races and the wall support a pressure differential between one side and the other side of the wall. Preferably, the bearings are contact sealed bearings. Contact sealed bearings have seals that are fixed to one of the races of the bearing and make sliding contact with the other race of the bearing. Such bearings are manufactured for example by SKF Ltd. and NSK Ltd. The inventors have found that sealed bearings "2RS" sold by SKF and sealed bearings "DDU" sold by NSK provide a relatively good low pressure gas seal. The inventors have found that a dynamic seal, when used to control aspiration of suction cups in tandem transport system, in accordance with a preferred embodiment of the present invention, satisfactorily supports a pressure differential of 0.8 atmospheres with relatively low air leakage from one side to the other of the seal. Such low leakages are not detrimental to the operation of the system.

There is therefore provided, in accordance with a preferred embodiment of the present invention, an apparatus for duplex printing comprising: a first impression roller on which a first side of a sheet having a leading edge and a trailing edge is printed referenced to the leading edge; a second impression roller on which a second side of the sheet is printed; and a transport system that removes a printed sheet from the first impression roller and transports it to the second impression roller, the transport system comprising a perfector that receives the sheet and grips it along both the leading and trailing edges of the sheet, which perfector turns the sheet over and transfers the sheet trailing edge first towards the second impression roller.

Preferably, the perfector transfers the sheet with the trailing edge registered to the leading edge.

Additionally or alternatively, the perfector comprises a first array of suction cups that grips the sheet adjacent the leading edge and a second array of suction cups that grips the sheet adjacent the trailing edge. Preferably, the distance between the first and second suction cup arrays is adjustable to accommodate different size sheets.

Additionally or alternatively, the perfector comprises a shaft to which the arrays of suction cups are mounted. Preferably, the first and second arrays of suction cups are respectively connected via first and second internal channels in the shaft to at least one vacuum system that controls aspiration of suction cups in the arrays. Preferably, the first and second channels respectively have first and second orifices on the surface of the shaft and wherein the first orifice is displaced from the second orifice along the axis of the shaft. Preferably, the apparatus comprises first, second and third annular bearings mounted to the

shaft, wherein each bearing has an inner and outer race that sandwiches a plurality of rollers and at least one seal between the inner and outer race. Preferably the first orifice is located between the first and second bearings and the second orifice is located between the second and third bearings.

5 The apparatus preferably comprises a seal between the shaft and the inner race of each bearing.

Preferably, the apparatus comprises a housing mounted on the bearings, the housing having a housing wall formed with first and second through holes and having a cavity defined by a cavity surface, and wherein the first through hole is located between the first and second
10 bearings and the second through hole is located between the second and third bearings. Preferably, the apparatus comprises a seal between the outer race of each bearing and the cavity wall.

Preferably, the first and second through holes are connected to the at least one vacuum system via first and second pressure hoses respectively and wherein the suction cups of the
15 first and second suction cup arrays aspirate when the at least one vacuum system respectively draws air through the first and second pressure hoses.

In some preferred embodiments of the present invention the annular bearings are contact sealed bearings.

In some preferred embodiments of the present invention the perfector comprises at least
20 one sheet support surface on which the sheet lies when it is held by the perfector. Preferably, the apparatus comprises a fan that creates airflow that presses the sheet flat to the at least one sheet support surface.

There is further provided, in accordance with a preferred embodiment of the present invention a dynamic seal for providing a gas seal between a shaft and a surface that enables
25 the shaft to rotate with respect to the surface comprising: a contact sealed bearing comprising rollers sandwiched between an inner race and an outer race and a seal between the inner and outer races that protects the rollers from dirt; a gas seal between the inner race and the shaft; and a gas seal between the outer race and the surface.

There is further provided, in accordance with a preferred embodiment of the present
30 invention, a sheet transport system for a printer that receives a sheet from an impression roller of the printer on which a first side of the sheet is printed referenced to a leading edge of the sheet and if the sheet is to be printed on its second side turns the sheet over and returns the

sheet to the impression roller, comprising: a conveyor belt that feeds a sheet placed thereon to the impression roller; a perfector that removes a sheet from the impression roller after a first side of the sheet is printed and if a second side of the sheet is to be printed, places the sheet on the conveyor belt, and if a second side is not to be printed moves the sheet towards a printer output tray, the perfector comprising:

first and second brackets independently rotatable about a same axis;

a plurality of suction cups mounted on each of the first and second brackets;

at least one sheet support surface mounted on each bracket; and

a system that rotates the brackets sequentially, one after the other remove printed sheets from the impression roller and either place the sheet on the conveyor or move the sheet towards the output tray.

Preferably, the at least one support surface comprised in a bracket is a relatively long narrow surface defined by a plane curve whose plane is perpendicular to the axis about which the first and second brackets rotate and wherein the radial distance from the axis to a point on the curve decreases as the distance of the point from the bracket increases. Preferably, the at least one support surface of the first bracket is axially displaced from the at least one support surface of the second bracket.

Some preferred embodiments of the present invention comprise a fan that creates an airflow that presses a sheet placed on the conveyor belt to the conveyor belt surface.

There is further provided, in accordance with a preferred embodiment of the present invention apparatus for transmitting vacuum to a device mounted on a rotating shaft comprising: first and second annular bearings mounted to the shaft so that there is a space between the bearings, wherein each bearing has an inner race and an outer race that sandwich a plurality of rollers and at least one seal between the inner and outer races; a seal between the inner race of each bearing and the shaft; a housing having a housing wall formed with a through hole, said housing wall forming together with said bearings a cavity that surrounds the shaft and communicates with said through hole; a seal between the housing wall and the outer race of each bearing; wherein said shaft is formed with an internal channel having a first aperture opening that communicates with said cavity and a second aperture communicating with said device.

Preferably the apparatus comprises a source of vacuum that communicates with the through hole to produce a vacuum in the cavity and thereby to transmit vacuum to the device.

Preferably, the apparatus comprises a third annular bearing that forms together with the second bearing and the housing wall an additional cavity that surrounds the shaft, wherein the bearing has an inner race and an outer race that sandwich a plurality of rollers and at least one seal between the inner and outer races. Preferably the apparatus comprises a seal between the inner race of the third bearing and the shaft. Preferably the apparatus comprises a seal between the outer race of the third bearing and the housing wall.

In some preferred embodiments of the present invention the housing wall is formed with an additional through hole that communicates with the additional cavity. Preferably, the shaft is formed with an additional internal channel that communicates with the additional cavity and with an additional device mounted to the shaft.

Preferably, the vacuum system communicates with the through hole and the additional through hole to control vacuum in the cavity and the additional cavity independently of each other and thereby to independently control vacuum transmitted to the device and the additional device.

In some preferred embodiments of the present invention at least one of the seals is an o-ring seal.

In some preferred embodiments of the present invention the pressure attained in the vacuum transmitted to the device and the additional device is less than 0.03 atmospheres.

In some preferred embodiments of the present invention the bearings are contact sealed bearings.

BRIEF DESCRIPTION OF FIGURES

The invention will be more clearly understood from the following description of preferred embodiments thereof read with reference to figures attached hereto. In the figures, identical structures, elements or parts that appear in more than one figure are generally labeled with the same numeral in all the figures in which they appear. Dimensions of components and features shown in the figures are chosen for convenience and clarity of presentation and are not necessarily shown to scale. The figures are listed below.

Figs. 1A and 1D-1I schematically show in cross-sectional view a tandem perfector transport system removing a sheet from a first impression roller of a printer, turning the sheet over and transporting the sheet to a second impression roller of the printer, in accordance with a preferred embodiment of the present invention;

Figs. 1B and 1C schematically show perspective views of a picker and a perfector comprised in the transport system shown in side views in Figs 1A and 1D-1I;

Figs. 2A-2D schematically show the transport system shown in Fig. 1A transporting a sheet from the first impression roller to the second impression roller without turning the sheet over, in accordance with a preferred embodiment of the present invention;

Fig. 3 schematically shows dynamic seals used to couple a vacuum pump to suction cups of a transporter, in accordance with a preferred embodiment of the present invention

Fig. 4 schematically shows in perspective view a perfector transporter comprising two pick and place arms, in accordance with a preferred embodiment of the present invention;

Figs. 5A - 5F show the operation of a re-feed perfector transport system comprising a perfector transporter similar to that shown in Fig. 4, in accordance with a preferred embodiment of the present invention; and

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Figs. 1A and 1D-1I schematically show side views of a tandem sheet transport system comprised in a tandem printer as the transport system removes a sheet 22 from a first impression roller 24 of the printer, turns the sheet over and feeds the sheet to a second impression roller 26 of the printer, in accordance with a preferred embodiment of the present invention. Only elements of the printer that are required for the discussion of transport system 20 are shown in Figs. 1A and 1D-1I. Rollers 28 represent any suitable devices in the printer for printing an image on a sheet held by impression rollers 24 and 26. For example, a roller 28 might represent an intermediate transfer member or a photoreceptor roller of an electrographic printing engine. For clarity of discussion it is assumed that rollers 28 represent intermediate transfer members. Direction of rotation of impression rollers 24 and 26 and intermediate transfer members 28 are shown by arrows.

Referring to Fig. 1A, sheet transport system 20 preferably comprises a picker transporter 30, a perfector 32, a transfer transporter 34, a feed transporter 36 and a second picker transporter 38. Preferably, sheet transport system 20 comprises at least one fan 33 positioned over perfector 32, which blows air in the direction of the perfector. Preferably, transport system 20 comprises an edge sensor 35 that senses positions of a leading edge and a trailing edge of a sheet that is transported by the transport system at times during which the sheet is located on the perfector. Preferably transport system 20 also comprises a by-pass transporter 40. By-pass transporter 40 is used when it is desired to transport sheet 22 to second

impression roller 26 without turning sheet 22 over. By-pass transporter 40 does not function in the transportation of sheet 22 to impression roller 26 shown in Figs. 1A-1G. The operation of by-pass transporter 40 is discussed below and schematically illustrated in Figs. 2A-2C. Picker 30 and perfecter 32, which are shown in the side view of transport system 20 in Figs. 1A and 1D-1G, are shown in perspective views in Figs. 1B and 1C respectively.

In Fig. 1A and figures that follow, to prevent clutter of the figures, unless required for clarity, generally only one feature of a plurality of features that are referred to by a same numeral is labeled by the numeral.

Picker 30, preferably comprises two linear arrays 42 of suction cups 44 and preferably two rim structures 46 that form two sheet support surfaces 48. In the side view of transport system 20 shown in Figs 1A-1G only one suction cup 44 of a linear suction cup array 42 and only one rim structure 46 is shown. Suction cups 44 in an array 42 are mounted to a manifold 50. Rim structures 46 are preferably connected to a shaft 52 via spokes 54, only one of which is labeled with a numeral. Manifolds 50 are mechanically coupled to shaft 52 by preferably being mounted to rim structures 46.

Manifold 50 of each suction cup array 42 is preferably connected via a pressure hose 56 to a preferably different "vacuum" channel (not shown) in shaft 52. The vacuum channels are coupled to an appropriate vacuum system that is controlled by a controller (not shown). The controller controls the vacuum system so that suction cups 44 of each suction cup array 42 suck and release air to respectively grip and release a sheet being transported by transport system 20 at appropriate times.

In some preferred embodiments of the present invention the "vacuum" channels in shaft 52 to which manifolds 50 are coupled are connected to the vacuum system using conventional techniques and conventional devices, such as rotary joints and conventional dynamic seals. Preferably, the channels are connected to the vacuum system using dynamic seals in accordance with a preferred embodiment of the present invention that are discussed below and schematically shown in Fig. 3.

The perspective view of picker 30 shown in Fig. 1B shows a vacuum distributor 62, which is mounted near an end 63 of shaft 52, that comprises a sealed cavity (not shown) for each vacuum channel in shaft 52 (there are two vacuum channels in shaft 52). Each cavity couples a different one of the vacuum channels to the vacuum system via a different one of pressure hoses 64 and 66. The cavities in vacuum distributor housing 62, are preferably sealed

using dynamic seals (not shown), in accordance with a preferred embodiment of the present invention. Details of internal features of vacuum housing 62 are shown in Fig. 3 and discussed in the discussion of Fig. 3.

Returning to Fig. 1A transfer transporter 34, feed transporter 36 and second picker 38 preferably have a construction similar to that of picker 30. Each of these transporters preferably rotate with a constant rotational speed in a direction indicated by the arrows inside the transporter. Feeder 36 and second picker 38 are preferably identical to picker 30. Transfer transporter 34 is preferably larger than picker 30 and preferably comprises three linear arrays 43 of suction cups 44 and two rim structures 47.

In a preferred embodiment of the present invention the relative diameters of transfer transporter 34, picker 30 (and picker 38 and feeder 36) and impression roller 24 (and 26) are about 3:2:1. Preferably each of these transporters and impression rollers rotates with a substantially constant angular velocity.

Their relative angular velocities are preferably inversely proportional to their diameters. Perfector 32, shown also in perspective view in Fig. 1C, preferably comprises a shaft 68, arrays 70 and 72 of suction cups 44 connected to manifolds 50 and "sector rim structures" 74 that form sheet support surfaces 76. Manifolds 50 are preferably mounted to sector rim structures 74. Preferably, the positions of at least one of manifolds 50 is adjustable so that a distance between suction cup arrays 70 and 72 can be adjusted to accommodate different size sheets. In some preferred embodiments of the present invention a manifold 50 is adjusted manually. In some preferred embodiments of the present invention the position of a manifold 50 is adjusted using small actuators or motors. Fig. 1C schematically shows two actuators 51 mounted sector rim frames 74 to adjust the position of one of manifolds 50. Each manifold 50 is connected to a different vacuum channel (not shown) in shaft 68 via a pressure hose 56. Similarly to the other transporters in transport system 20, the vacuum channels are appropriately connected to a vacuum system, preferably via a vacuum housing 62.

Rim structures 74 of perfector 32 are constructed substantially different from the rim structures of other transporters in sheet transport system 20. Sheets transported by perfector 32 are always located between suction cup arrays 70 and 72. As a result a full rim structure is not required for perfector 32. In addition, unlike the other transporters in transport system 20, which move with substantially a constant rotational velocity, perfector 32 accelerates and decelerates relatively rapidly and changes direction of rotation when transport system 20 turns

over a sheet that it transports between impression rollers 24 and 26. The "sector structure" of sector rim structures 74 results in a rim structure substantially less massive than a "full" rim structure. The lighter mass of sector rim structures 74 facilitates accelerating perfector 32 rapidly. Perfector 32 is preferably driven by a motor 78, which is connected to shaft 68, preferably, by pulleys 80 and a transmission belt 82. Preferably, transmission belt 82 is a timing belt and pulleys 80 are splined pulleys. The controller controls motor 78 to provide desired motion of perfector 32. Preferably, the controller controls motor 78 responsive to signals that it receives from edge sensor 35 and from an encoder (not shown) that monitors the position of second impression roller 26. The signals are preferably used to adjust rotational speed of perfector 32 to adjust transport system 20 for variance in the length of sheets transported by the system and errors in the position of a sheet held by perfector 32. Adjusting the rotational velocity of perfector 32 to accommodate errors in the position of a sheet transported by a sheet transport system similar to that described in the present application is discussed in PCT application PCT/IL99/00600 referenced above. PCT/IL99/00600 also describes a system useable for fine tuning the position of a sheet immediately prior to its being fed to second impression roller 26. In some preferred embodiments of the present invention, sheet transport system 20 comprises a sheet position fine tuning system similar to that described in PCT/IL99/00600. The direction of rotation of perfector 32 in Figs. 1A and 1D-1G is shown by the direction of the arrow inside the perfector. In Fig. 1A perfector 32 is rotating clockwise.

In Fig. 1A a first side of sheet 22 is shown being printed on impression roller 24. An arrow 90 in Fig. 1A and figures that follow indicate the printed side of sheet 22. Sheet 22 has a leading edge 92 and a trailing edge 94. Printing on the first side of sheet 22 is referenced to leading edge 92. Impression roller 24 is rotated to a position at which leading edge 92 is located at a hand off position between impression roller 24 and picker 30. Picker 30 is rotated so that one of its suction cup arrays 42 is also at the pick off position. The vacuum system to which the suction cup array 42 is connected is controlled so that suction cups 44 in the array suck in air and grip sheet 22 along leading edge 92. As picker 30 and impression roller 24 continue to rotate, sheet 22 rolls off impression roller 24 and onto support surfaces 48 of picker 30. At this stage of moving sheet 22 to second impression roller 26 perfector 32 is rotating clockwise.

In Fig. 1D perfector 32 and picker 30 have rotated to a sheet hand off position between the picker and the perfector. Suction cup array 70 of perfector 32 is opposite leading edge 92 of sheet 22 and suction cup array 70 aspirates air and grips the leading edge while suction cup array 42 of picker 30 releases the leading edge. In addition, perfector 32, which had been rotating clockwise, is controlled by motor 78 to reverse direction and rotate counterclockwise in synchronism with picker 30.

As picker 30 and perfector 32 continue to rotate, sheet 22 rolls off picker 30 and onto perfector 32. Air blown by fan 33 in the direction of perfector 32 presses sheet 22 firmly to sheet support surfaces 76 of the perfector.

Fig. 1E shows perfector 32 still rotating counterclockwise and rotated to a position at which sheet 22 is completely transferred to perfector 32. Suction cup array 72 of perfector 32 is now opposite trailing edge 94 of sheet 22 and is controlled to aspirate and grip trailing edge 94. Sheet 22 is now firmly held on perfector 32 by both its leading edge 92 and its trailing edge 94 and the position of trailing edge 94 on the perfector is accurately registered to the position of leading edge 92 on the perfector. The printed side of sheet 22 is face up on perfector 32 as indicated by arrow 90.

After securing sheet 22 by its leading and trailing edges, perfector 32 continues rotating counterclockwise until *trailing* edge 94 is at a hand off position between perfector 32 and transfer transporter 34.

Fig. 1F shows the positions of perfector 32 and transfer transporter at the hand off position. At the hand off position, perfector 32 reverses its direction of rotation and begins to rotate clockwise, to match the counterclockwise rotation of transfer transporter 34 and a suction cup array 43 of transfer transporter 34 grips trailing edge 94. Suction cup array 72 of perfector 32 releases trailing edge 94 and as transfer transporter 34 and perfector 32 continue to rotate, sheet 22 rolls onto transfer transporter 34 and suction cup array 70 of the perfector releases leading edge 92 of sheet 22. Sheet 22 is then completely on transfer transporter 34, held on the transfer transporter by trailing edge 94 and with the printed surface of sheet 22 face down, as indicated by arrow 90.

Even though transfer transporter 34 grips sheet 22 by trailing edge 94, the position of sheet 22 on the transporter is registered to leading edge 92, since perfector 32 handed off trailing edge 94 to transfer transporter 34 with the position of trailing edge 94 accurately registered to the position of leading edge 92. As a result, in further hand-offs between

transporters as transport system 20 moves sheet 22 to impression roller 26, which are accomplished by handing off *trailing* edge 94 of sheet 22, the position of sheet 22 remains registered to leading edge 92.

Fig. 1G shows transfer transporter 34 handing off trailing edge 94 (at this point the leading edge) of sheet 22 to feeder 36 and Fig. 1H shows feeder 36 feeding sheet 22 to second impression roller 26 with sheet 22 oriented so that its printed side is down on the impression roller. Preferably, sheet transport system 20 comprises a sheet position fine adjustment system that adjust the timing of the transfer of sheet 22 from feeder 36 to second impression roller 26, as described in PCT application PCT/IL99/00600. Fig. 1I shows second picker 38 gripping trailing edge 94 as the picker begins removing sheet 22 from impression roller 26 after the second side of sheet 22 is printed.

Figs. 2A-2D schematically show the operation of transport system 20 when sheet 22 is transported from impression roller 24 to impression roller 26 without turning over sheet 22. Fig. 2A is identical to Fig. 1A and shows picker 30 removing sheet 22 from impression roller 24 after a first side of the sheet is printed. The orientation of the printed side of sheet 22 is shown by arrow 90. Perfector 32 is rotating clockwise.

However, unlike the transport process shown in Figs. 1A and 1D-1I, in the transport process shown in Figs. 2A-2D, picker 30 does not hand off sheet 22 to perfector 32. Instead, picker 30 hands off sheet 22 to by-pass transporter 40, as shown in Fig. 2B. By-pass transporter 40 then hands off sheet 22 to perfector 32 as shown in Fig. 2C. After receiving sheet 22, perfector 32 does not reverse its direction of rotation but continues rotating clockwise to hand off sheet 22 to transfer transporter 34, as shown in Fig. 2D. As a result, perfector 32 does not turn over sheet 22. From transfer transporter 34, sheet 22 is handed off towards impression roller 26 as shown in Figs. 1G-1I. However, when sheet 22 is fed to impression roller 26, sheet 22 rolls onto impression roller with the *printed* side face up, rather than face down as in the sheet transfer process shown in Figs. 1A and 1D-1I. It should be noted that in the sheet transport process shown in Figs. 2A-2D sheet 22 is always held by leading edge 92 and transfer of sheet 22 from one transporter to another is always done by handing off leading edge 92. The position of sheet 22 on second impression roller 26 is therefore automatically registered to leading edge 92.

When transfer system 20 is configured to use by-pass transporter 40, the transport system transports sheets substantially more rapidly between impression roller 24 and

impression roller 26 than when the system is configured to turn over a page when it transports a sheet between the rollers. Therefore, when the printer comprising transport system 20 is used to print only one side of a sheet, a higher throughput of the printer can be achieved when transport system 20 is configured to use by-pass transporter.

5 In addition, when the printer is used to print both sides of a sheet, transporter 40 is advantageously used to check color density on both sides of the sheet with a single in-line densitometer. Assume for example that the densitometer is located so that it checks the color density on a sheet while the sheet is on second impression roller 26. Therefore, under normal duplex operation the densitometer checks color density on the second side of the sheet (*i.e.* the
10 one printed on second impression roller 26). To check color density on the first side of the sheet, transport system 20 is switched to a calibration mode in which the system is configured to use by-pass transporter 40 and the printer is set to print only the first side of the sheet (*i.e.* the side printed on first impression roller 24). A sheet printed under these conditions when it rolls onto second impression roller 26 has the first side up on the impression roller and the
15 densitometer checks color density on the first side.

Fig. 3 shows a schematic cross-sectional view of a portion of shaft 52 of picker transporter 30, shown in Fig. 1B, which is mounted with vacuum distributor 62, in accordance with a preferred embodiment of the present invention. The cross-sectional view is taken along line A-A shown in Fig. 1B and illustrates a method of transmitting vacuum to suction cup
20 arrays 42 comprised in picker 30 using dynamic seals, in accordance with a preferred embodiment of the present invention.

Vacuum distributor 62 comprises a housing 100 having a circularly cylindrical cavity 102 defined by an inner cavity wall 104 of housing 100. Three preferably identical annular rotary bearings 105, 106 and 107 are mounted inside cavity 102. Preferably bearings 105, 106
25 and 107 are contact sealed bearings. Each bearing 105, 106 and 107 comprises a plurality of appropriate cylindrical or spherical rollers 108 and an inner race 110 and an outer race 112. Grease seals 114 on either side of rollers 108 protect the rollers from dirt. Preferably To prevent clutter, numerals identifying components of bearing 105, 106 and 107 are shown only for bearing 105.

30 The outer diameter of bearings 105, 106 and 107 are substantially equal to the diameter of cylindrical cavity 102 and the inner diameters of the bearings are substantially equal to the diameter of shaft 68. An annular spacer 115 is preferably placed between adjacent bearing 105

and 106 to maintain a desired distance between the bearings. Similarly an annular spacer 117 is placed between bearing 106 and 107. Spacers 115 and 117 preferably have an outer diameter substantially equal to the diameter of cylindrical cavity 102 and are preferably press fit into cavity 102 so that once in place they cannot rotate inside the cavity. Spacers 115 and 117 have
5 a radial wall thickness preferably sufficiently thin so that they contact bearings between which they are placed only along outer races 112 of the bearings. A lip 118 in housing 100 and a cover plate 120 preferably secure bearings 106 and spacers 116 inside cavity 102.

For each bearing 105, 106 and 107 an o-ring or other suitable seal 122 is seated in an appropriate groove in inner wall 104 of housing 100 contacts and presses against outer race
10 112 of the bearing. O-ring 122 provides a gas seal between race 112 of the bearing and cavity wall 104. Similarly, for each bearing 105, 106 and 107 an o-ring or other suitable seal 123 is seated in an appropriate groove in shaft 68 opposite inner race 110 of the bearing. O-ring 123 provides a gas seal between race 112 of the bearing and the surface of shaft 68. For each bearing 105, 106 and 107 grease seals 114 of the bearings and gas seals provided by o-rings
15 122 and 123 provide a gas seal between shaft 68 and cavity wall 104 that supports a pressure differential between the two sides of the bearing. In addition the bearings and seals enable shaft 68 to rotate freely within vacuum distributor 62. Bearings 105, 106 and 107 and their associated o-ring seals therefore function as low torque dynamic seals and create two separate sealed annular cavities 125 and 127 between shaft 68 and cavity wall 104 of vacuum
20 distributor 62. An inlet hole 128 to cavity 125 passes through housing 100 and spacer 115 and an inlet hole 129 to cavity 127 similarly passes through housing 100 and spacer 117. Inlet holes 128 and 129 are connected via pressure hose 64 and 66 respectively to the vacuum system (not shown) that generates vacuum for suction cup arrays 42 of picker 30.

Shaft 68 is formed with two channels 130 and 132 that are preferably parallel to the
25 axis of shaft 68. Channels 130 and 132 are not connected to each other. Channel 130 has an inlet hole 134 and an outlet hole 136, each of which connects channel 130 with the surface of shaft 68. Inlet hole 134 is located so that it communicates with sealed annular cavity 127. Outlet hole 136 is connected via pressure hose 56 to one of suction cup arrays 42 of picker 30 (Fig. 1B). Channel 132 similarly has an inlet hole 138 and an outlet hole 140. Inlet hole 138 is
30 positioned so that it communicates with annular sealed cavity 125. Outlet hole 140 is connected to the other of suction cup arrays 42 of picker 30 via a pressure hose 57. Channels

130 may be formed for example by drilling appropriate holes through end 69 of shaft 68 and plugging the holes with plugs 141.

Vacuum distributor 62 enables each of suction cup arrays 42 of picker 30 to be controlled independently of each other. When the vacuum system draws air through pressure hose 64 air is drawn through channel 132 and from the suction cups in the suction cup array 42 to which channel 132 is connected. The direction of air flow through channel 132 and annular cavity 125 when air is drawn through pressure hose 64 is shown by solid arrow. When the vacuum system draws air through pressure hose 66 air is drawn through channel 130 and from the suction cups in the suction cup array 42 to which channel 130 is connected. The direction of air flow through channel 130 and annular cavity 127 when air is drawn through pressure hose 66 is shown by dashed arrows.

It should be noted that whereas vacuum distributor 62 is shown transmitting vacuum to two channels in shaft 68 a similar vacuum distributor comprising more than three low torque dynamic seals can be used to transmit vacuum to more than two channels in a rotating shaft, in accordance with a preferred embodiment of the present invention. Furthermore, whereas vacuum distributor 62 has been described as transmitting vacuum it can of course also be used to transmit low pressure to channels in a rotating shaft.

It should be noted that inlet hoses 64 and 66 do not rotate with shaft 68 and can thus be freely connected to a stationary source of vacuum. The vacuum at outlet hoses 56 and 57 rotates and thus can be attached to any structure that rotates with the shaft. Thus, the vacuum at hoses 56 and 57 can be controlled by controlling the vacuum at hoses 64 and 66.

Furthermore, while Fig. 3 shows a two way distributor, an extended structure of the same type (using an rotating seal and channel for each input/output) can be used for any number of channels of vacuum. Furthermore, both sides of the shaft are fitted with distributors.

Fig. 4 schematically shows in a perspective view a perfector 200 for use with a duplex printing machine that prints both sides of a sheet on a same impression roller.

Perfector 200 preferably comprises two pick and place arms 201 and 203 preferably having bracket arms 202 and 204 respectively. Bracket arms 202 and 204 are rotatably mounted, preferably on two pin shafts 206 and 208, so that each bracket arm is independently rotatable about a same axis 210. Bracket arm 202 is preferably fixed to pin shaft 208 and rotatable about pin shaft 206. Similarly bracket arm 204 is preferably fixed to pin shaft 206 and rotatable about pin shaft 208.

Pin shaft 206 is coupled to a motor 212 preferably via pulleys 214 and a transmission belt 216. Preferably transmission belt 212 is a timing belt and pulleys 214 are splined pulleys. Bracket arm 204 rotates about axis 210 when motor 212 rotates pin shaft 206. Similarly, pin shaft 208 is coupled to a motor 218 that controls the rotation of pin shaft 208 and thereby the rotation of bracket arm 202 about axis 210.

Bracket arm 204 is mounted with a plurality of suction cups 220 and preferably at least two crescent structures 222 having sheet support surfaces 224. By way of example, bracket arm 204 is mounted with four suction cups 220 and two crescents 222. Preferably, a crescent 222 is mounted between each outer pair of suction cups 220. The radial distances of all suction cups 220 from axis 210 are preferably equal. Preferably, the radial distance of a region of a support surface 224 from axis 210 decreases slightly as the distance of the region from bracket arm 204 increases.

A channel inside bracket arm 204 communicates with suction cups 220 and is connected to a suitable vacuum system using methods known in the art, which controls aspiration of suction cups 220. Bracket arm 202 is preferably similarly mounted with suction cups 230 and crescents 232 having sheet support surfaces 234. Suction cups 230 and sheet support surfaces 234 lie on the same circularly cylindrical surface on which suction cups 220 and sheet support surfaces 224 lie. Crescent 222 and 232 are displaced from each other in a direction parallel to axis 210 so that bracket arms 204 and 202 can be rotated so that they are close to each other. When bracket arms 204 and 202 are close, crescents 222 interleave with crescents 232. The decrease in radial distance of regions of sheet support surfaces 224 and 234 prevents a sheet being held by one pick and place arm from being abraded by the sheet support surface of the other pick and place arm when the two pick and place arms are close together.

Figs. 5A-5F schematically show side views of a sheet transport system 250 and illustrate its operation, in accordance with a preferred embodiment of the present invention. Figs 5A-5F show sheet transport system removing a sheet from an impression roller 252 of a printer (not shown) after a first side of the sheet is printed, turning the sheet over and returning the sheet to impression roller 252 for printing a second side of the sheet. A roller 254 represents any suitable device for printing an image on a sheet held on impression roller 252. Since the image on the two sides of the sheet are generally different, the printing device is preferably a digital printing device such as an electrophotographic device. Roller 254 may be, for example, an intermediate transfer member of a printer.

Referring to Fig. 5A, sheet transport system 250 comprises the perfecter 200 shown in a perspective view in Fig. 4, a conveyor belt 256 having a surface 257 and at least one fan 258. An arrow inside conveyor 256 indicates a direction of motion of surface 257. A first side of a sheet 22 is being printed on impression roller 252 as it rolls onto impression roller 252 from a feed tray 253. A gripper 251 on impression roller 252 holds a leading edge 92 of sheet 22. An arrow 90 indicates the printed side of sheet 22. Bold curved arrows on pick and place arms 201 and 203, hereinafter "arms 201 and 203", indicate direction of rotation of the arms, which are both moving clockwise. Suction cups 220 of pick and place arm 203 are approaching a hand off position between impression roller 252 and perfecter 200.

At the handoff position suction cups 220 of arm are controlled to aspirate and grip leading edge 92. As arm 203 and impression roller 252 continue rotating after suction cups 220 grip leading edge 92, sheet 22 rolls off impression roller 252 and onto sheet support surfaces 224 of arm 203.

Fig. 5B shows transport system 250 after a substantial portion of sheet 22 has rolled onto sheet support surfaces 224 and a next sheet 23 is being fed to impression roller 252. Sheet support surfaces 224 contribute to a smooth roll off of sheet 22 from impression roller 252 and to reducing fluctuations in a force with which arm 203 pulls sheet 22 off impression roller 252. Support surfaces 224 also substantially reduce damage to sheet 22 from kinking or wrinkling of the sheet in regions near to suction cups 220. As arm 201 and impression roller 252 continue to rotate sheet 22 leaves impression roller 252 and is drawn by airflow created by fan 258 to conveyor surface 257.

Fig. 5C shows sheet 22 and positions of arms 201 and 203 at a time at which sheet 22 has just rolled completely off impression roller 252 and lies flat on conveyor surface 257. At this time arm 201 reverses its direction of rotation so that it rotates counterclockwise and moves sheet 22 in the direction of motion of conveyor surface 257 so that a trailing edge 94 of sheet 22 approaches a hand off position between conveyor 257 and impression roller 252. Airflow from fan 258 and the motion of conveyor surface 257 substantially prevent "billowing" of sheet 22 on conveyor surface 257 and maintain relatively accurate registration of the position of trailing edge 94 to the position of leading edge 92.

Gripper 251 holds a leading edge of sheet 23 which is being printed on impression roller 252 and arm 201 is rotating clockwise to pick up the leading edge at the handoff position between impression roller 252 and perfecter 200.

In Fig. 5D arm 201 is beginning to remove sheet 23 from impression roller 252 and suction cups 230 of arm 201 are gripping the leading edge of sheet 23 which is being released by gripper 251. Arm 203 is still moving counterclockwise and together with conveyor belt surface 257 are moving trailing edge 94 of sheet 22 to meet gripper 251.

5 In Fig. 5E trailing edge 94 has reached the hand off position between conveyor surface 257 and impression roller 252. Gripper 251 is gripping trailing edge 94 of sheet 22 and sheet 22 is beginning to roll onto impression roller 252 with its first printed side face down on the roller. Suction cups 230 are releasing leading edge 92 of sheet 22 and arm 203 is reversing its direction of rotation so that it rotates clockwise and returns to impression roller 252 to pick up
10 a next sheet from the impression roller. As sheet 22 rolls onto impression roller 252 its second side will be printed.

The next sheet that arm 203 removes from impression roller 252 is again sheet 22, but this time after the second side of sheet 22 is printed. Arm 203 does not of course return sheet 22 to impression roller 252 after the sheet's second side is printed. Instead of placing sheet 22
15 on conveyor surface 257 and reversing its direction of rotation from clockwise to counterclockwise arm 203 continues clockwise rotation and passes sheet 22 to a sheet transporter that moves sheet 22 towards an out tray. Fig. 5F shows arm 203 handing off sheet 22 after the second side of the sheet has been printed to a transporter 260 that moves the sheet towards an out tray.

20 It should be noted that a tandem sheet transport system, in accordance with a preferred embodiment of the present invention, removes sheets printed on a first impression roller of a tandem printer and feeds the sheets to a second impression roller of the printer as fast as they are printed so that a first side of a sheet is printed with every rotation of the impression roller. Similarly, a re-feed transport system, in accordance with a preferred embodiment of the
25 present invention, comprised in a printing that prints both sides of a sheet on a same impression roller transports sheets at a rate such that a side of a sheet is printed with every rotation of the printer's impression roller.

In the description and claims of the present application, each of the verbs, "comprise" "include" and "have", and conjugates thereof, are used to indicate that the object or objects of
30 the verb are not necessarily a complete listing of members, components, elements or parts of the subject or subjects of the verb.

The present invention has been described using detailed descriptions of preferred embodiments thereof that are provided by way of example and are not intended to limit the scope of the invention. The described preferred embodiments comprise different features, not all of which are required in all embodiments of the invention. Some embodiments of the present invention utilize only some of the features or possible combinations of the features. Variations of embodiments of the present invention that are described and embodiments of the present invention comprising different combinations of features noted in the described embodiments will occur to persons of the art. The scope of the invention is limited only by the following claims.

CLAIMS

1. Apparatus for duplex printing comprising:
a first impression roller on which a first side of a sheet having a leading edge and a
5 trailing edge is printed referenced to the leading edge;
a second impression roller on which a second side of the sheet is printed; and
a transport system that removes a printed sheet from the first impression roller and
transports it to the second impression roller, the transport system comprising a perfector that
receives the sheet and grips it along both the leading and trailing edges of the sheet, which
10 perfector turns the sheet over and transfers the sheet, trailing edge first, towards the second
impression roller.
2. Apparatus according to claim 1 wherein the perfector transfers the sheet with the
trailing edge registered to the leading edge.
- 15 3. Apparatus according to claim 1 or claim 2 wherein the perfector comprises a first array
of suction cups that grips the sheet adjacent the leading edge and a second array of suction
cups that grips the sheet adjacent the trailing edge.
- 20 4. Apparatus according to claim 3 wherein the distance between the first and second
suction cup arrays is adjustable to accommodate different size sheets.
5. Apparatus according to claim 3 or claim 4 wherein the perfector comprises a shaft to
which the arrays of suction cups are mounted.
- 25 6. Apparatus according to claim 5 wherein the first and second arrays of suction cups are
respectively connected via first and second internal channels in the shaft to at least one
vacuum system that controls aspiration of suction cups in the arrays.
- 30 7. Apparatus according to claim 6 wherein the first and second channels respectively have
first and second orifices on the surface of the shaft and wherein the first orifice is displaced
from the second orifice along the axis of the shaft.

8. Apparatus according to claim 7 and comprising first, second and third annular bearings mounted to the shaft, wherein each bearing has an inner and outer race that sandwiches a plurality of rollers and at least one seal between the inner and outer race.

5

9. Apparatus according to claim 8 wherein the first orifice is located between the first and second bearings and the second orifice is located between the second and third bearings.

10. Apparatus according to claim 9 and comprising a seal between the shaft and the inner race of each bearing.

10

11. Apparatus according to claim 10 and comprising a housing mounted on the bearings, the housing having a housing wall formed with first and second through holes and having a cavity defined by a cavity surface, and wherein the first through hole is located between the first and second bearings and the second through hole is located between the second and third bearings.

15

12. Apparatus according to claim 11 and comprising a seal between the outer race of each bearing and the cavity wall.

20

13. Apparatus according to claim 12 wherein the first and second through holes are connected to the at least one vacuum system via first and second pressure hoses respectively and wherein the suction cups of the first and second suction cup arrays aspirate when the at least one vacuum system respectively draws air through the first and second pressure hoses.

25

14. Apparatus according to any of claims 8-13, wherein the annular bearings are contact sealed bearings.

15. Apparatus according to any of claims 1-14 wherein the perfecter comprises at least one sheet support surface on which the sheet lies when it is held by the perfecter.

30

16. Apparatus according to claim 15 and comprising a fan that creates airflow that presses the sheet flat to the at least one sheet support surface.

17. A dynamic seal for providing a gas seal between a shaft and a surface that enables the shaft to rotate with respect to the surface comprising:

a contact sealed bearing comprising rollers sandwiched between an inner race and an outer race and a seal between the inner and outer races that protects the rollers from dirt;

a gas seal between the inner race and the shaft; and

a gas seal between the outer race and the surface.

18. A sheet transport system for a printer that receives a sheet from an impression roller of the printer on which a first side of the sheet is printed referenced to a leading edge of the sheet and if the sheet is to be printed on its second side, turns the sheet over and returns the sheet to the impression roller, comprising:

a conveyor belt that feeds a sheet placed thereon to the impression roller;

a perfector that removes a sheet from the impression roller after a first side of the sheet is printed and if a second side of the sheet is to be printed, places the sheet on the conveyor belt, and if a second side is not to be printed, moves the sheet towards a printer output tray, the perfector comprising:

first and second brackets independently rotatable about a same axis;

a plurality of suction cups mounted on each of the first and second brackets;

at least one sheet support surface mounted on each bracket; and

a system that rotates the brackets sequentially, one after the other to remove printed sheets from the impression roller and either place a removed sheet on the conveyor or move the sheet towards the output tray.

19. A sheet transport system according to claim 18 wherein the at least one support surface mounted on a bracket is a relatively long narrow surface defined by a plane curve whose plane is perpendicular to the axis about which the first and second brackets rotate and wherein the radial distance from the axis to a point on the curve decreases as the distance of the point from the bracket increases.

20. A sheet transport system according to claim 19 wherein the at least one support surface of the first bracket is axially displaced from the at least one support surface of the second bracket.
- 5 21. A sheet transport system according to any of claims 18-20 and comprising a fan that creates airflow that presses a sheet placed on the conveyor belt to the conveyor belt surface.
22. An apparatus for transmitting vacuum to a device mounted on a rotating shaft comprising:
- 10 first and second annular bearings mounted to the shaft so that there is a space between the bearings, wherein each bearing has an inner race and an outer race that sandwich a plurality of rollers and at least one seal between the inner and outer races;
- a seal between the inner race of each bearing and the shaft;
- a housing having a housing wall formed with a through hole, said housing wall
- 15 together with said bearings forming a cavity that surrounds the shaft and communicates with said through hole;
- a seal between the housing wall and the outer race of each bearing;
- wherein said shaft is formed with an internal channel having a first aperture that communicates with said cavity and a second aperture communicating with said device.
- 20 23. Apparatus according to claim 22 and comprising a source of vacuum that communicates with the through hole to produce a vacuum in the cavity and thereby to transmit vacuum to the device.
- 25 24. Apparatus according to claim 23 and comprising a third annular bearing that forms together with the second bearing and the housing wall an additional cavity that surrounds the shaft, wherein the bearing has an inner race and an outer race that sandwich a plurality of rollers and at least one seal between the inner and outer races.
- 30 25. Apparatus according to claim 24 and comprising a seal between the inner race of the third bearing and the shaft.

26. Apparatus according to claim 24 or claim 25 and comprising a seal between the outer race of the third bearing and the housing wall.

27. Apparatus according to any of claims 24-26 wherein the housing wall is formed with an additional through hole that communicates with the additional cavity.

28. Apparatus according to claim 27 wherein the shaft is formed with an additional internal channel that communicates with the additional cavity and with an additional device mounted to the shaft.

29. Apparatus according to claim 28 wherein the source of vacuum communicates with the through hole and the additional through hole to control vacuum in the cavity and the additional cavity independently of each other and thereby to independently control vacuum transmitted to the device and the additional device.

30. Apparatus according to any of claims 22-29 wherein at least one of the seals is an o-ring seal.

31. Apparatus according to any of claims 22-30 wherein the pressure attained in the vacuum transmitted to the device and the additional device is less than 0.03 atmospheres.

32. Apparatus according to any of claims 22-31 wherein the bearings are contact sealed bearings.

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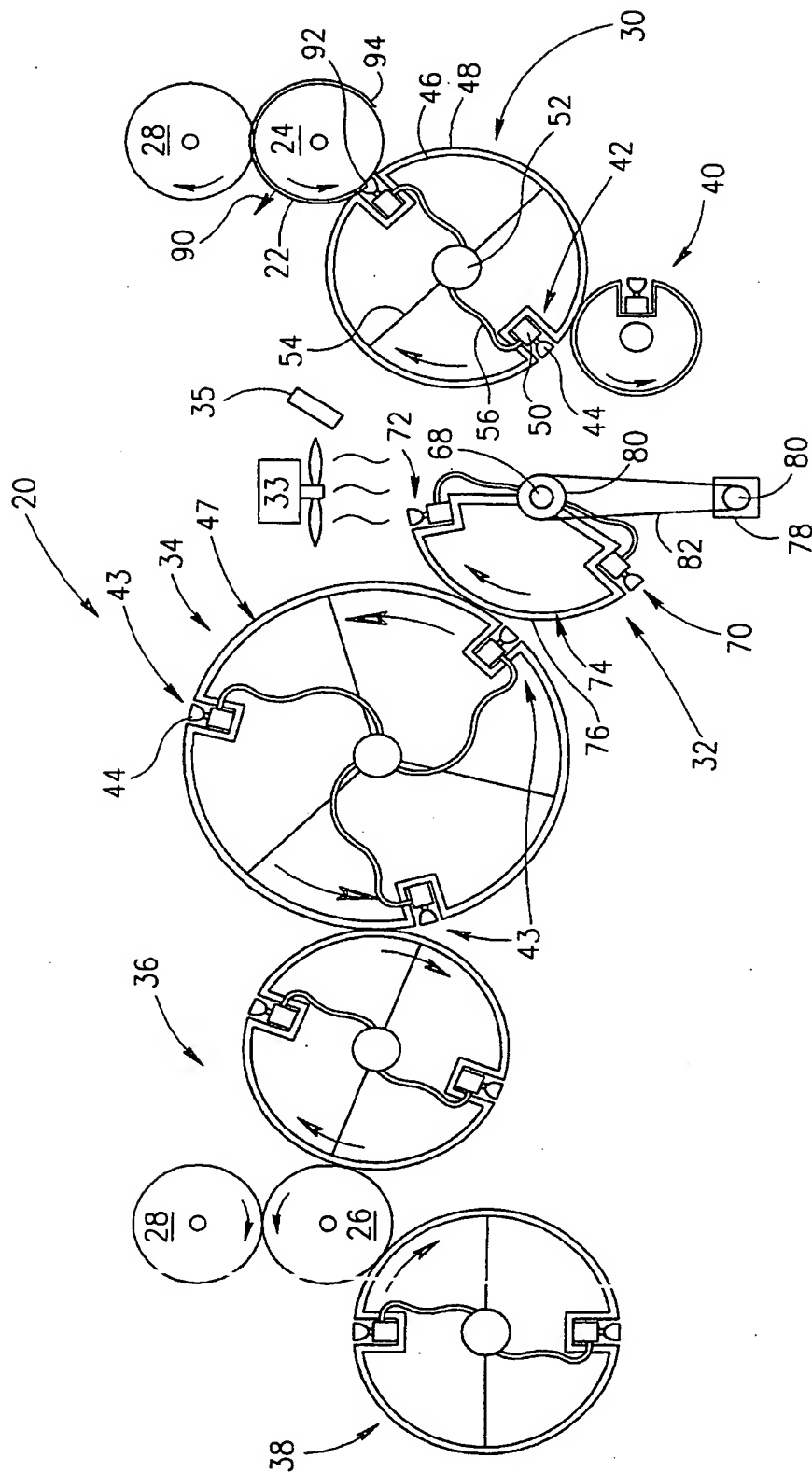


FIG. 1A

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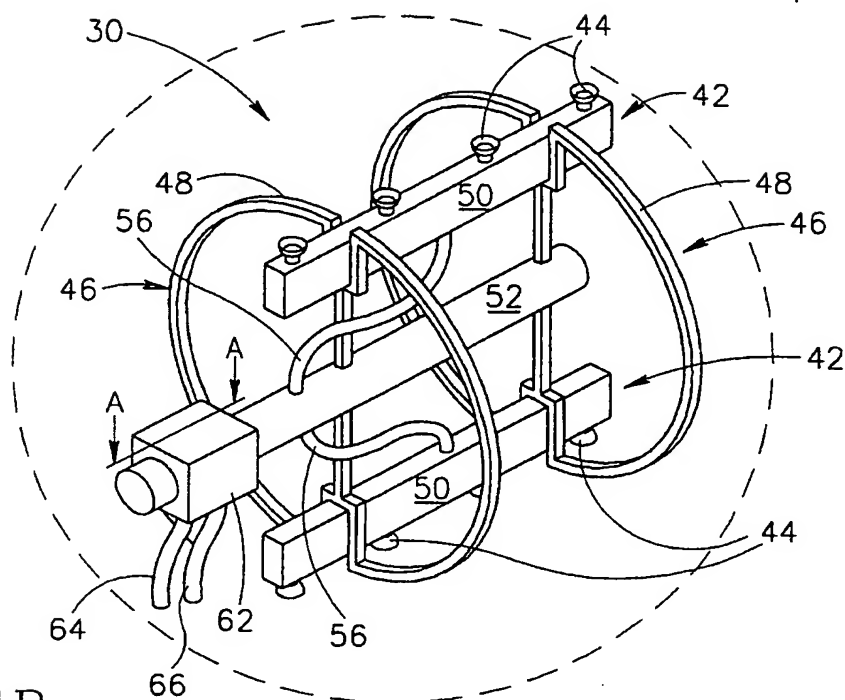


FIG. 1B

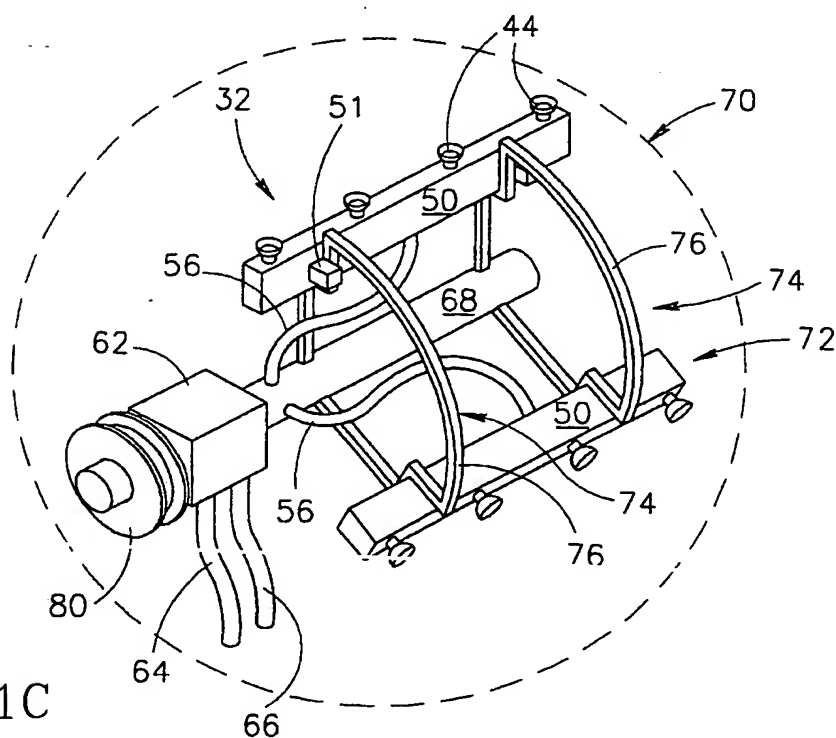


FIG. 1C

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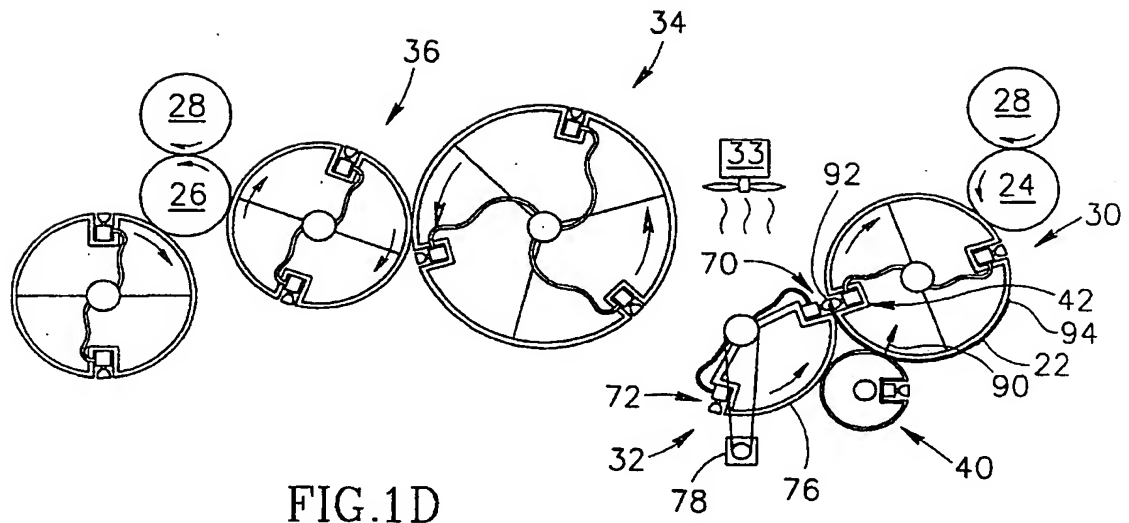


FIG. 1D

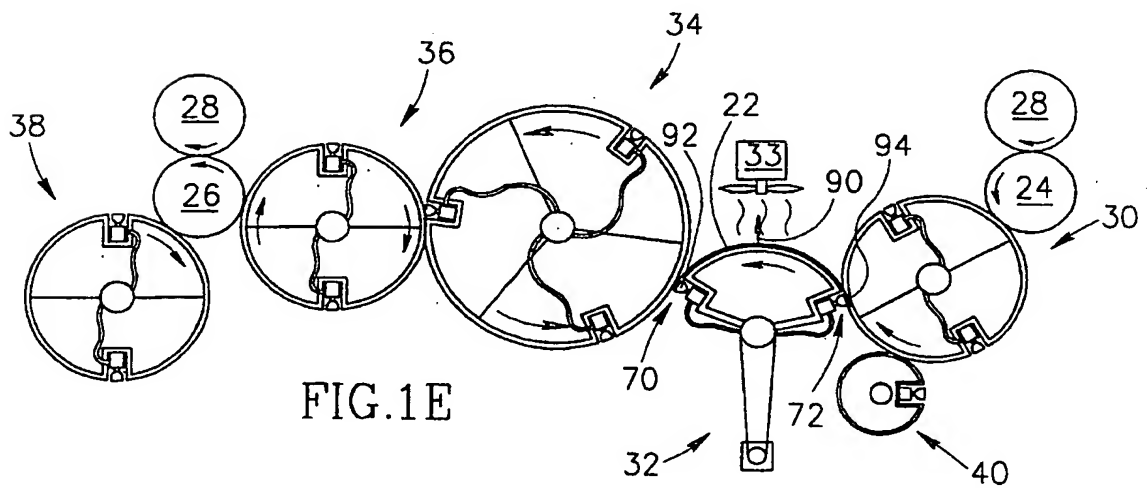
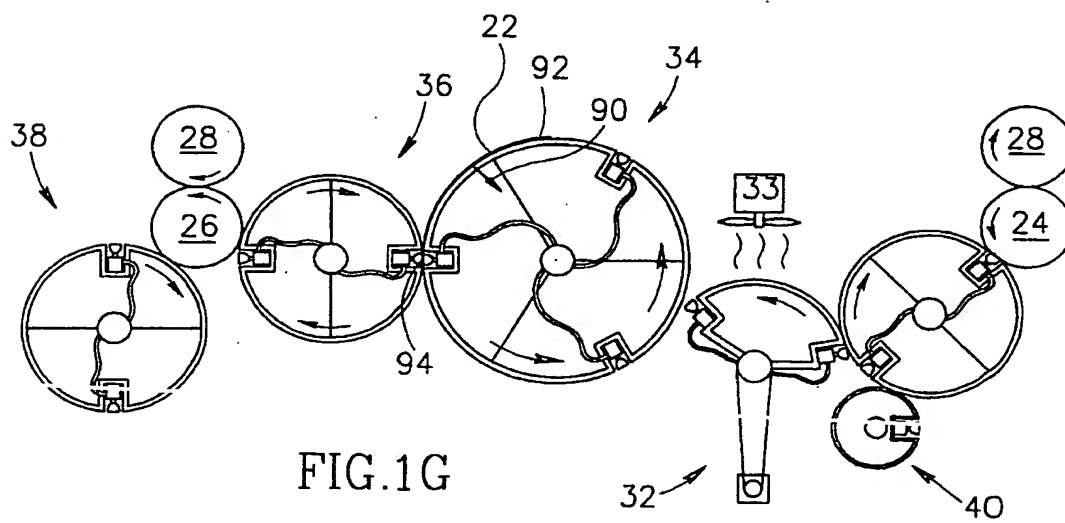
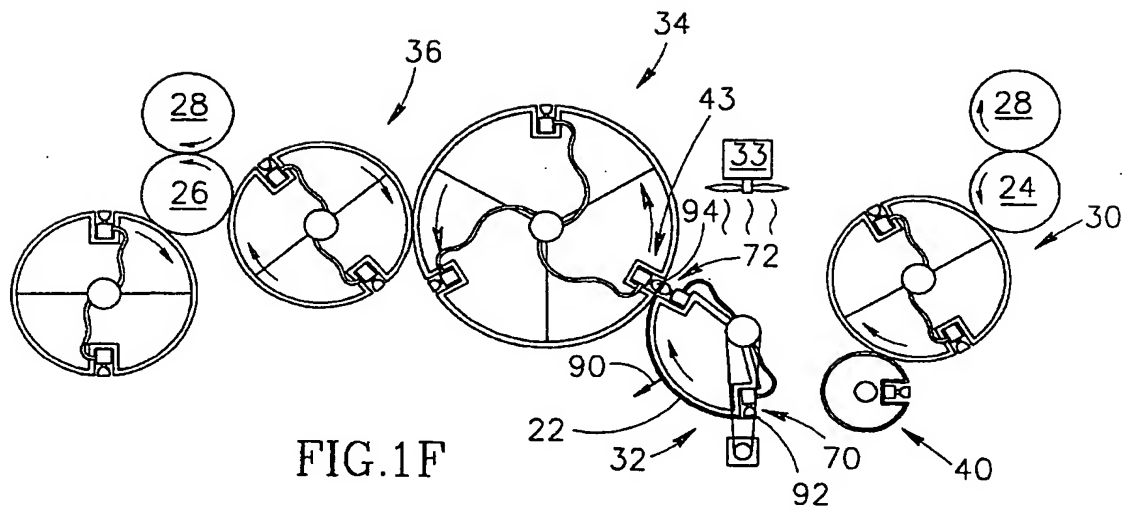


FIG. 1E

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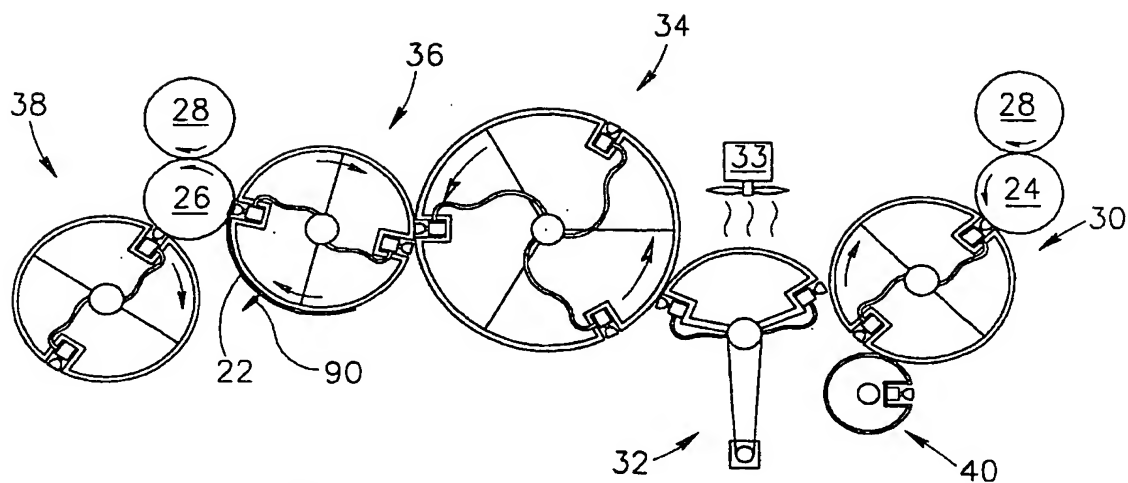


FIG. 1H

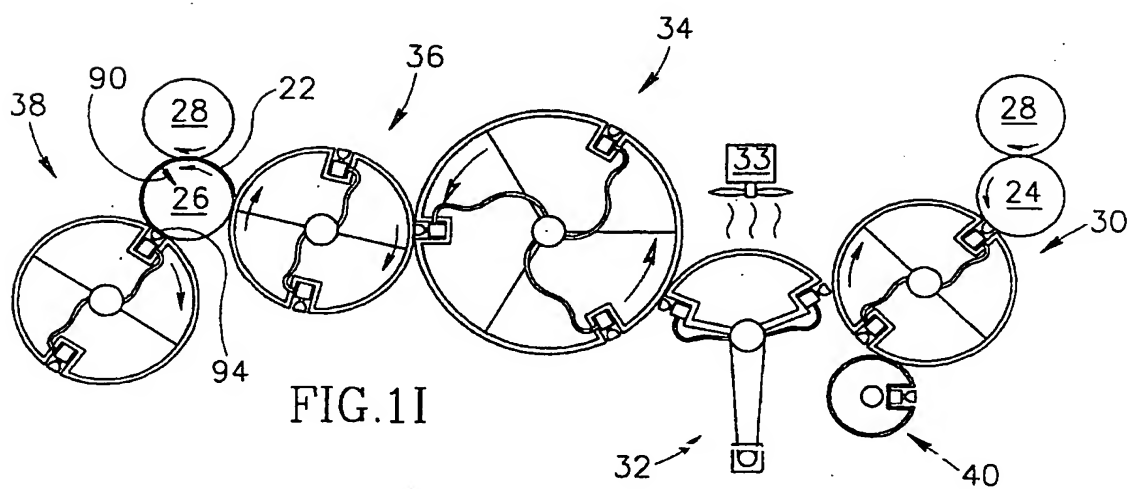


FIG. 1I

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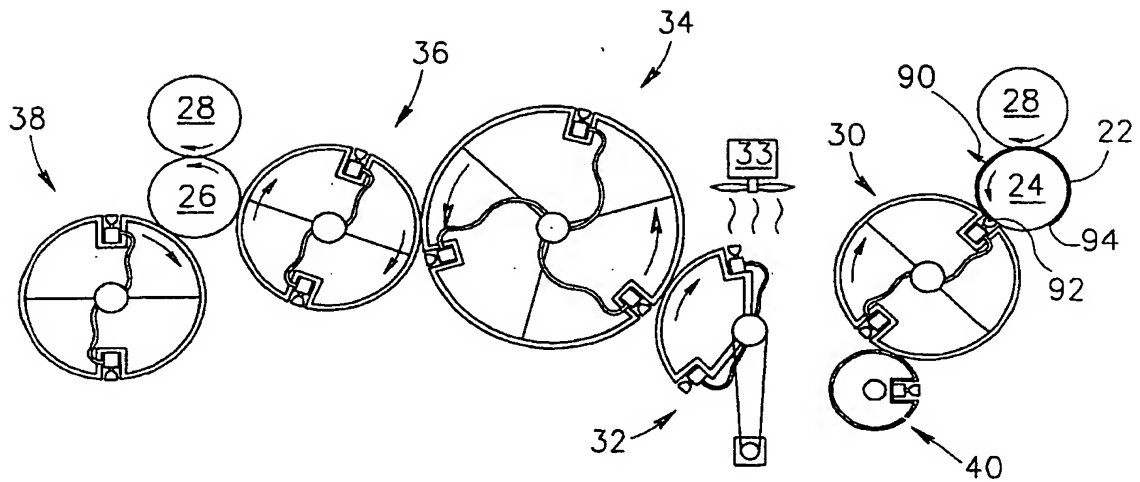


FIG. 2A

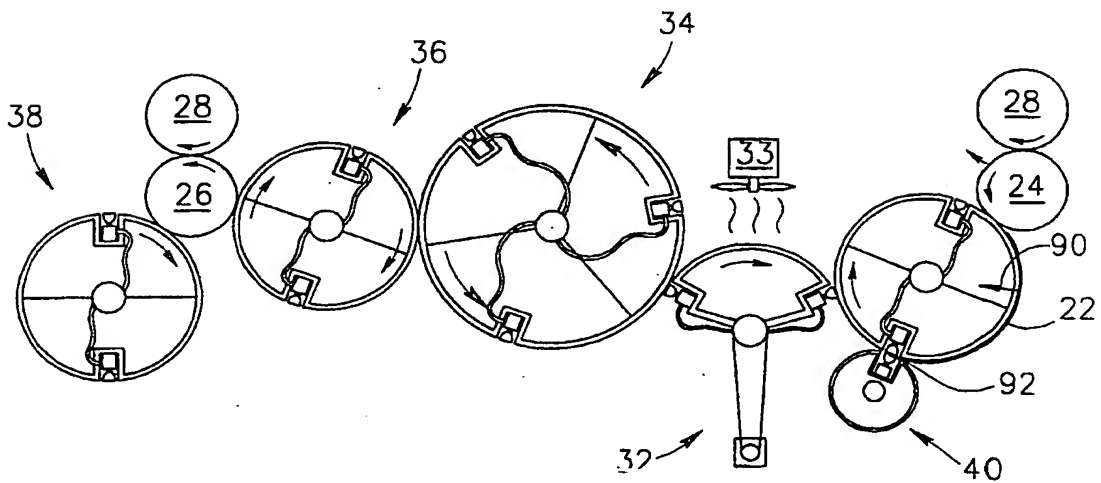
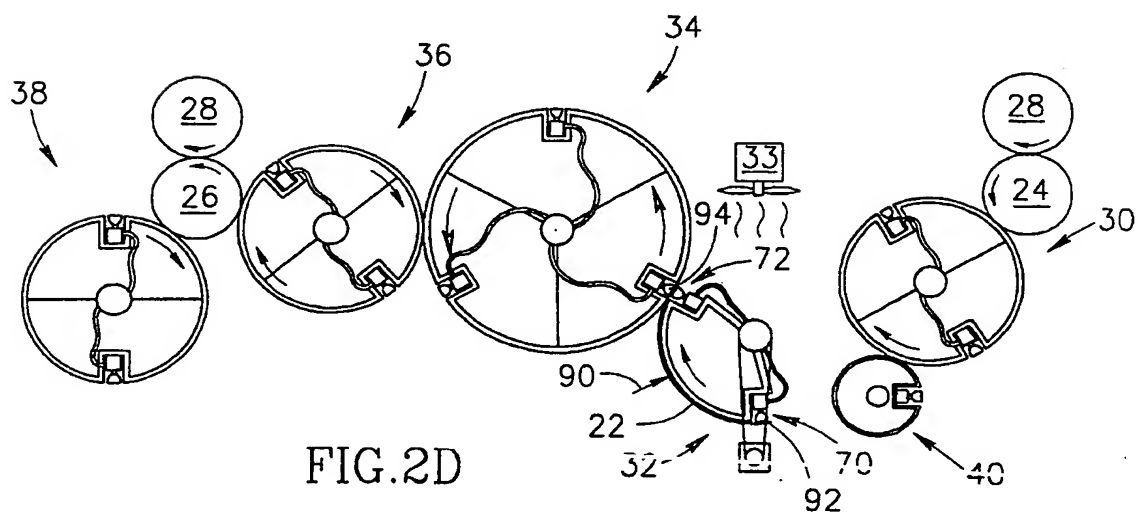
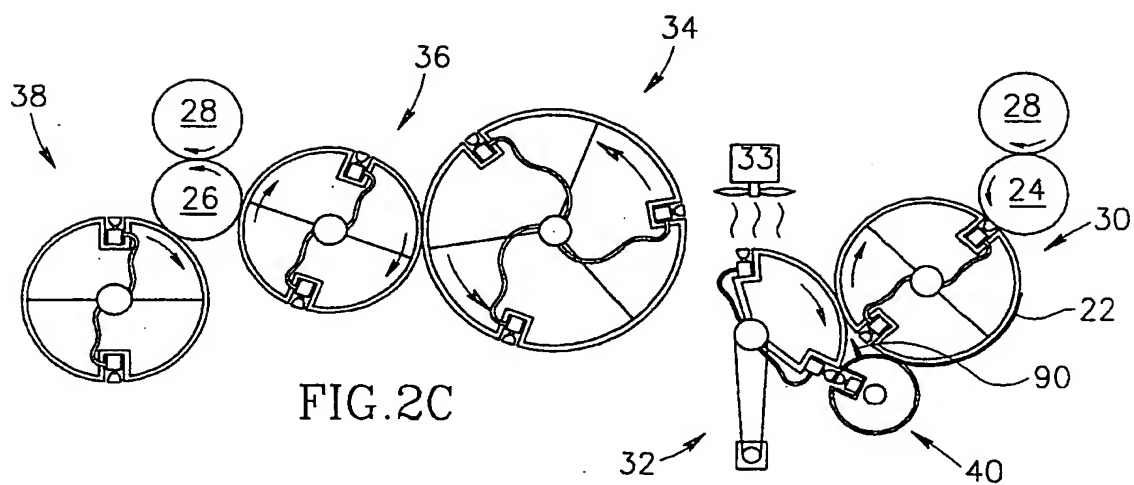
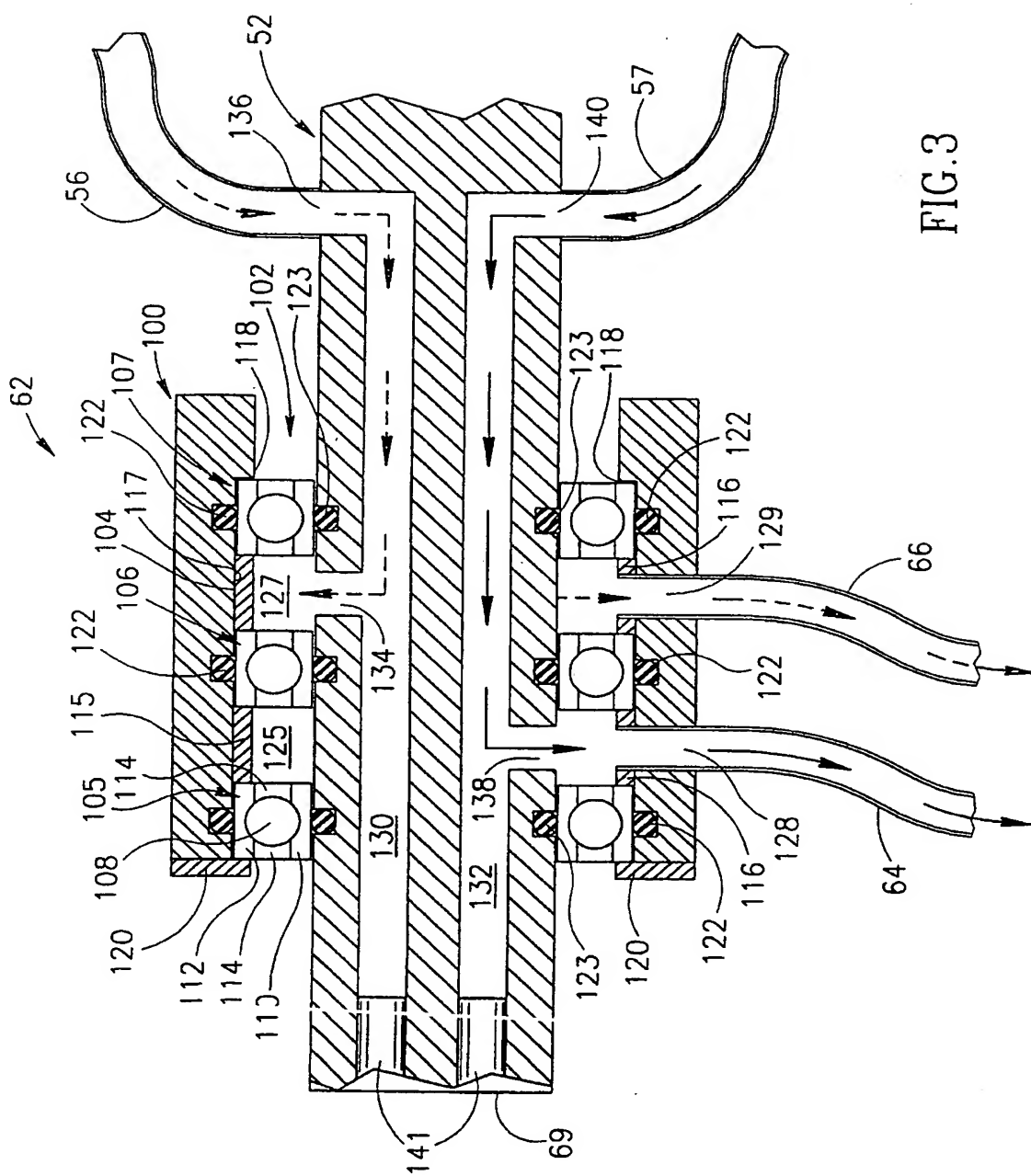


FIG. 2B

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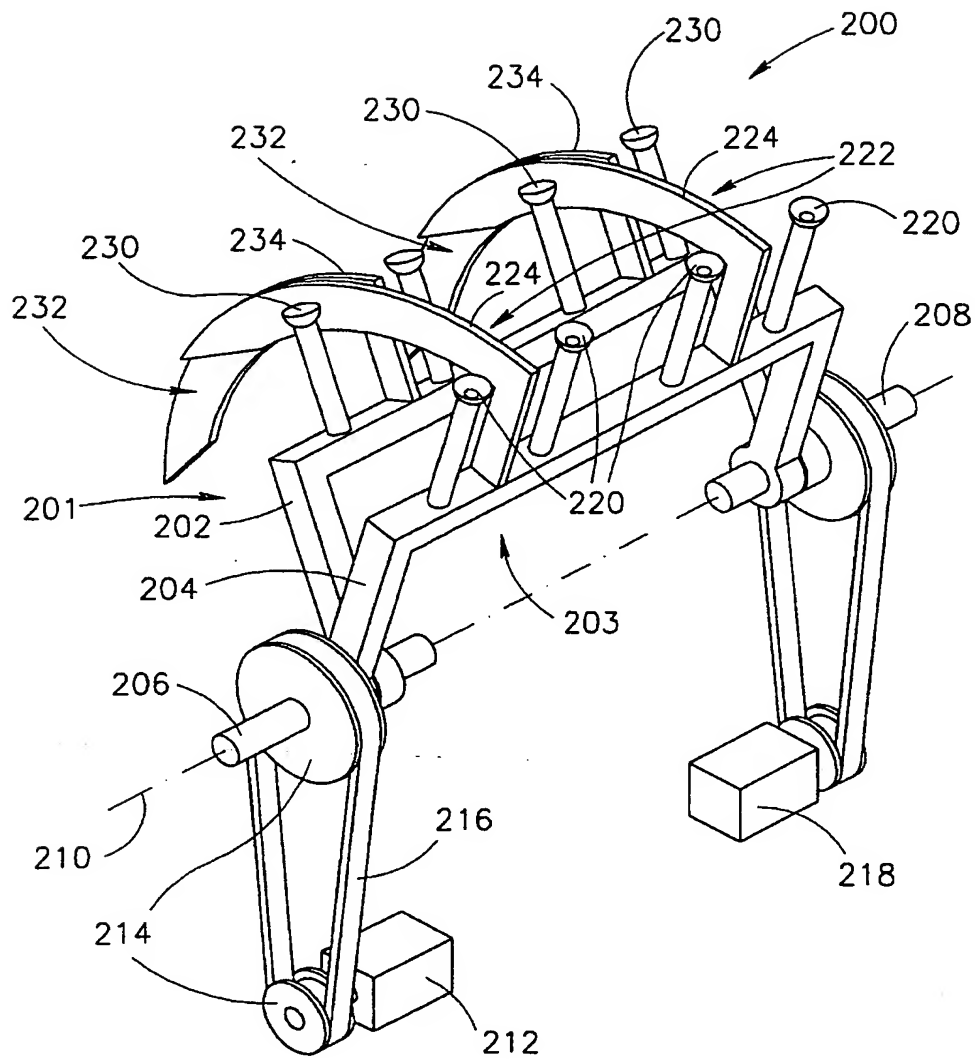
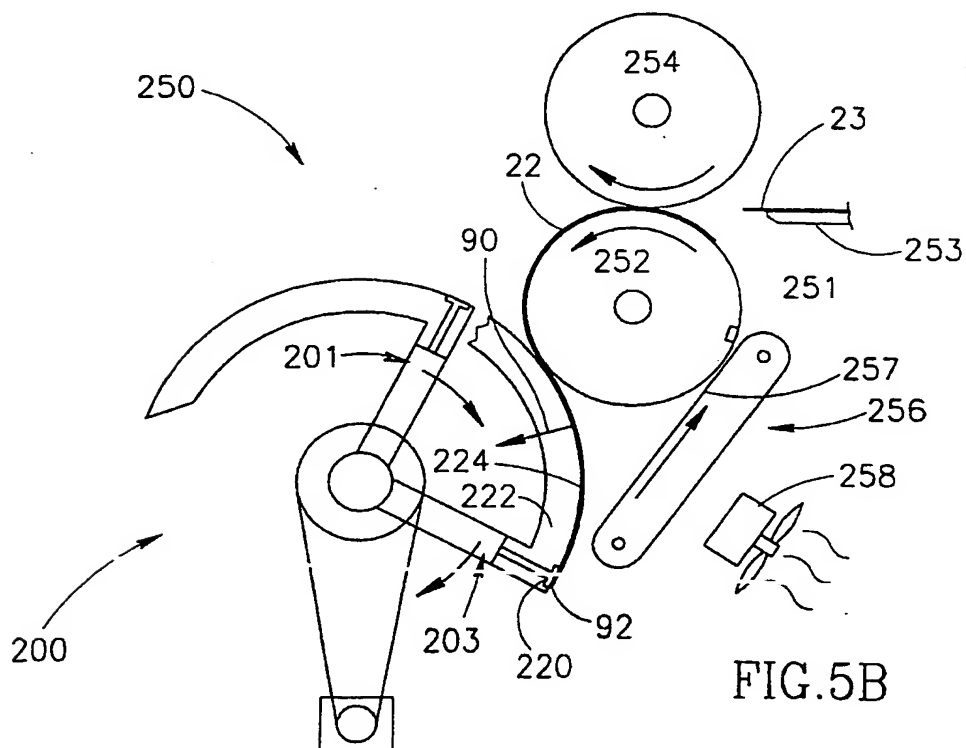
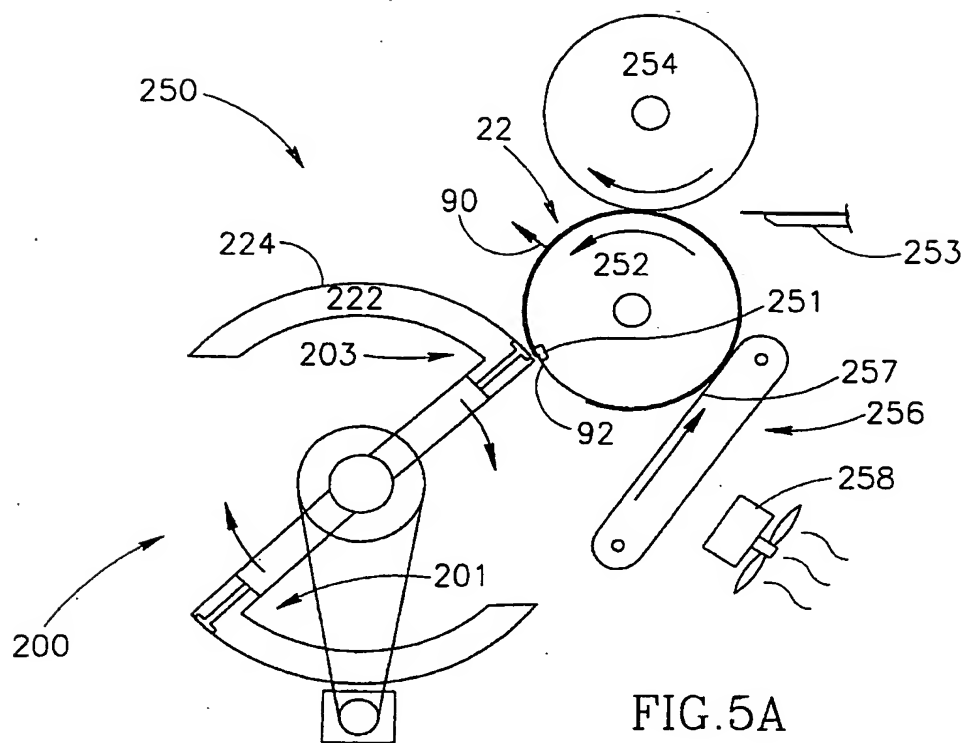
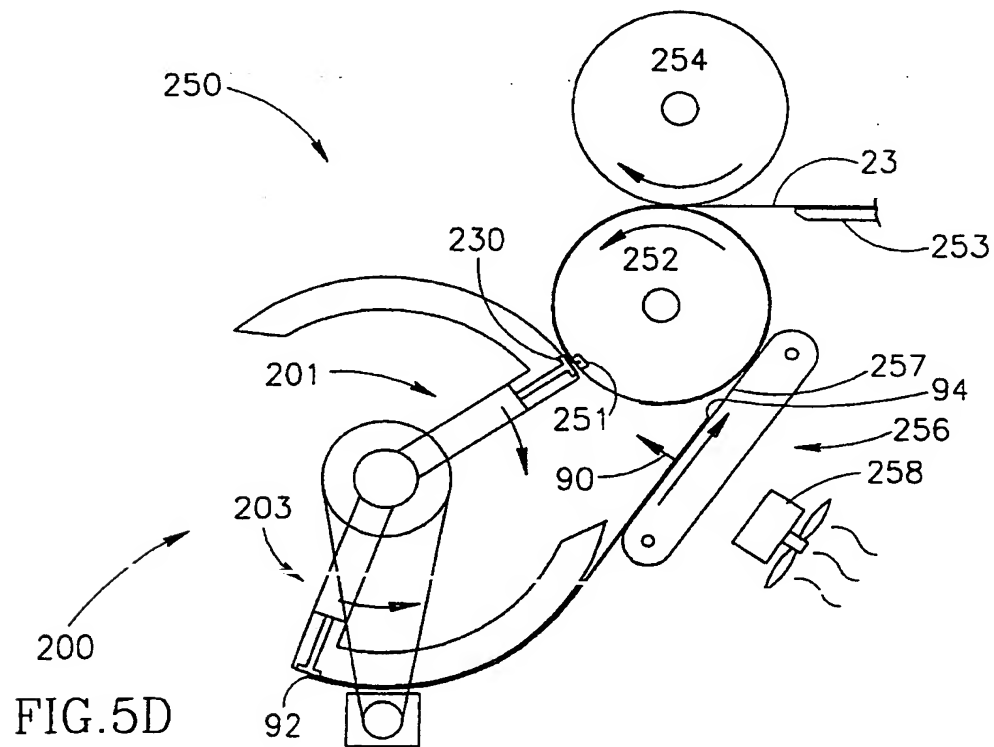
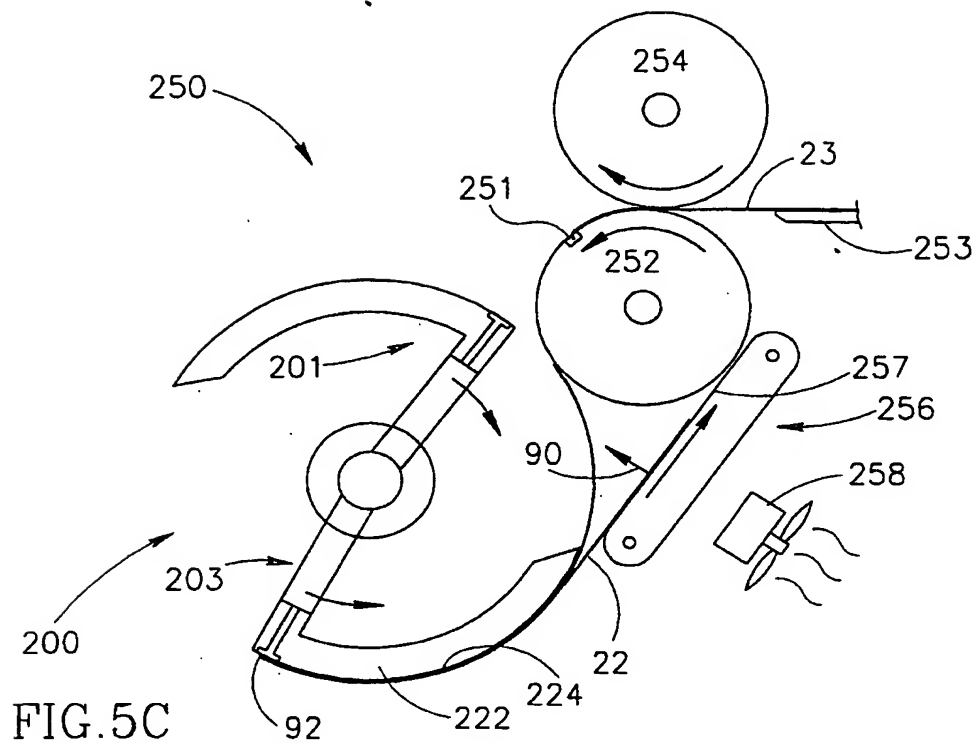


FIG. 4

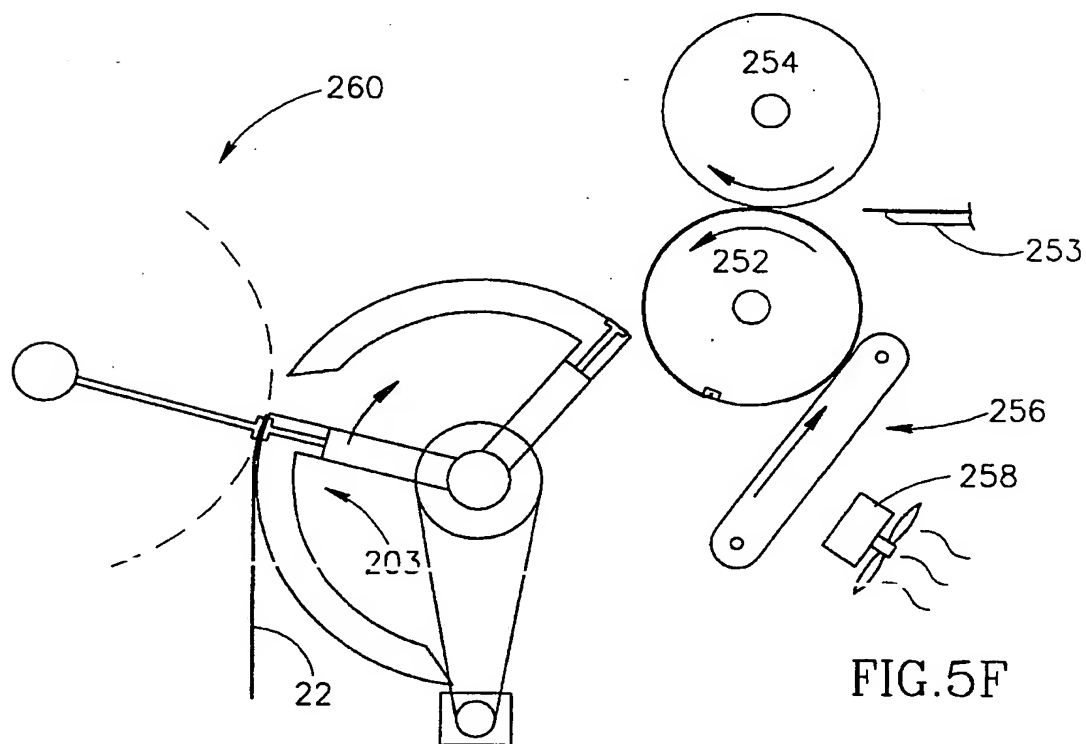
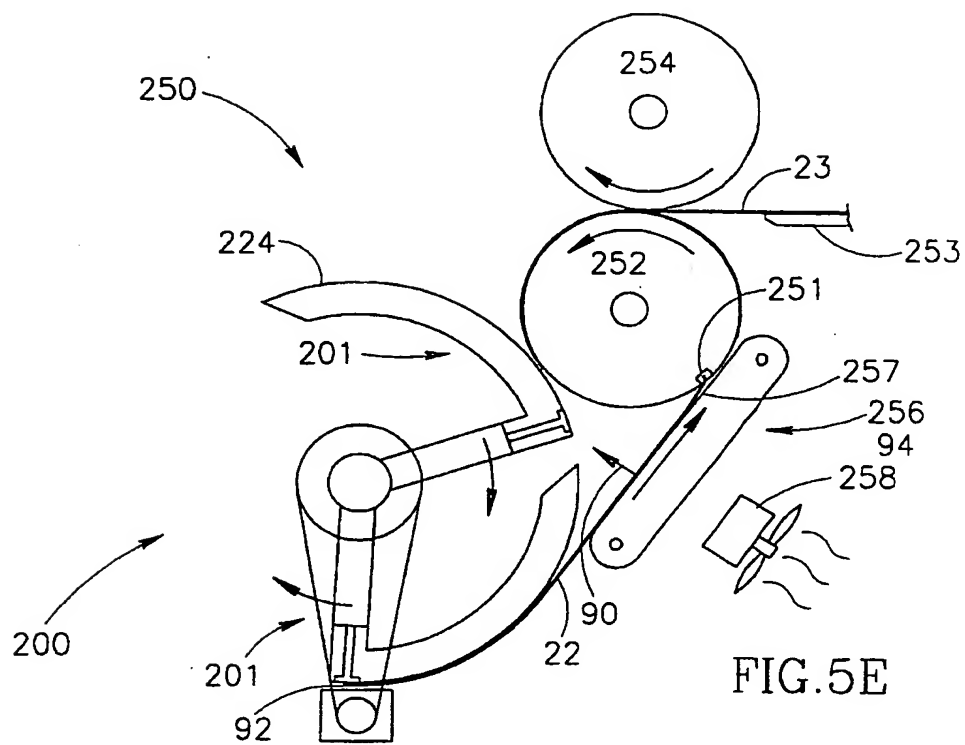
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PATENT COOPERATION TREATY

PCT

REC'D 18 MAR 2002

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)



Applicant's or agent's file reference PEI	FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/IL00/00081	International filing date (day/month/year) 07/02/2000	Priority date (day/month/year) 07/11/1999
International Patent Classification (IPC) or national classification and IPC B41F21/10		
Applicant INDIGO N.V. et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 6 sheets, including this cover sheet.
- ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 5 sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☐ Certain defects in the international application
- VIII ☐ Certain observations on the international application

Date of submission of the demand 31/10/2000	Date of completion of this report 14.03.2002
Name and mailing address of the international preliminary examining authority:  European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Fox, T Telephone No. +49 89 2399 2797 

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. PCT/IL00/00081

I. Basis of the report

1. With regard to the **elements** of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17):*)

Description, pages:

1-23 as originally filed

Claims, No.:

1-28 with telefax of 04/03/2002

Drawings, sheets:

1/12-12/12 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. PCT/IL00/00081

☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-28
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-28
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1-28
	No:	Claims	

- 2. Citations and explanations**
see separate sheet

V.

Claim 1:

The **closest prior art** is known from document EP-A-0 161 522 (D1) which discloses an apparatus for duplex printing wherein the perfector (15, Fig. 1) turns the sheet over and transfers the sheet to the second printing station. The perfector comprises only one gripping array for gripping the sheet at one edge. The apparatus according to claim 1 differs from the one according to D1 in that the perfector grips the sheet simultaneously along both the leading and trailing edges thereof.

The claimed apparatus is therefore new in the sense of Article 33(2) PCT.

The **object** of the present invention is to improve the accuracy with which the trailing edge of the sheet is registered to the leading edge of the sheet when printed on both sides.

This **object is achieved** by the above mentioned feature of claim 1 which distinguish the apparatus from the one known from D1.

None of the cited documents disclose or suggests such features.

The claimed apparatus involves therefore an inventive step in the sense of Article 33(3) PCT.

Claim 1 is not clear in the sense of Article 6 PCT, because the essential feature "the perfector rotates in a first direction when removing the sheet from a preceeding roller and rotates in an opposite direction when it passes of the sheet to a following transport element". Without this feature it is unclear how the perfector can turn over the sheet.

Claim 17:

The **closest prior art** is known from document US-A-4 202 268 (D2) which discloses a sheet transport system for a printer that receives a sheet from an impression roller of the printer on which a first side of the sheet is printed referenced to a leading edge of the sheet and if the sheet is to be printed on its second side, turns the sheet over and returns the sheet to the impression roller, comprising a perfector that removes a sheet form the impression roller after a first side of the sheet is printed and if a second side is not to be printed, moves the sheet towards a printer output tray, the perfector comprising:

first and second brackets independently rotatable about a same axis,
a plurality of suction cups mounted onto one bracket,

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and at least one sheet support surface mounted on each bracket.
The apparatus according to claim 17 differs from the one according to D1 in that the sheet transport system comprises a conveyor belt that feeds the sheet placed thereon to the impression cylinder, in that the perfector places the sheet onto the conveyor belt if a second side of the sheet is to be printed, in that additional to the first bracket a plurality of suction cups are mounted onto the second bracket, and in that it is provided with a system that rotates the brackets sequentially, one after the other to remove printed sheets from the impression roller and either place a removed sheet on the conveyor or move the sheet towards the output tray.

The claimed apparatus is therefore new in the sense of Article 33(2) PCT.

The **object** of the present invention is to remove a sheet from an impression roller and to selectively transfer the sheet to an output tray or back to the impression roller. This **object is achieved** by the two brackets which are independently rotatable about the same axis and which are rotated sequentially, one after the other to remove printed sheets from the impression roller and either place a removed sheet on the conveyor or move the sheet towards the output tray.

None of the cited documents disclose or suggests such features.

The claimed apparatus involves therefore an inventive step in the sense of Article 33(3) PCT.

The content of claim 21 goes beyond the disclosure in the international application as filed, because the only the brackets and not the whole perfector rotates in two different directions (see the embodiment according to Figs. 5a-5f). Consequently the requirements of Article 34 (2) (b) PCT are not met.

Claim 17 is not clear in the sense of Article 6 PCT, because the essential feature is missing that each bracket reverses its direction of rotation in order to turn over the sheet and to guide it for printing on its reverse side to the same impression roller.

Without this feature it is unclear how the perfector can turn over the sheet. It is furthermore unclear, whether the impression roller mentioned in context with the conveyor belt is the same as the first impression roller or a different one.

Claim 22:

The **closest prior art** is known from document EP-A-0 435 164 (D3) which discloses an apparatus for transmitting vacuum to a device mounted on a rotating shaft. The

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bearings are sealed with separated gaskets adjacent to the inner side of the bearings. The apparatus according to claim 22 differs from the one according to D3 in that bearings are grease sealed bearings wherein the grease acts as a vacuum seal for the cavity.

The claimed apparatus is therefore new in the sense of Article 33(2) PCT.

The **object** of the present invention is to improve the seal of an apparatus for transmitting vacuum to a device mounted on a rotating shaft.

This **object is achieved** by using the grease of the bearings as a vacuum seal, so that the construction of the apparatus is simplified and the additional gaskets as shown in D3 are not necessary.

None of the cited documents disclose or suggests such features. The claimed apparatus involves therefore an inventive step in the sense of Article 33(3) PCT.

Dependent claims

The dependent claims 2-16, 18-21, and 23-28 are directed to preferred embodiments of the subject matter of claims 1, 17 or 22 and likewise meet the requirements of Articles 33(2) and (3) PCT.

CLAIMS

1. Apparatus for duplex printing comprising:

5 a first impression roller on which a first side of a sheet having a leading edge and a trailing edge is printed referenced to the leading edge;

a second impression roller on which a second side of the sheet is printed; and

10 a transport system that removes a printed sheet from the first impression roller and transports it to the second impression roller, the transport system comprising a perfector that receives the sheet and grips it along both the leading and trailing edges of the sheet, which perfector turns the sheet over and transfers the sheet, trailing edge first, towards the second impression roller.

15 2. Apparatus according to claim 1 wherein the perfector transfers the sheet with the trailing edge registered to the leading edge.

3. Apparatus according to claim 1 or claim 2 wherein the perfector comprises a first array of suction cups that grips the sheet adjacent the leading edge and a second array of suction cups that grips the sheet adjacent the trailing edge.

20 4. Apparatus according to claim 3 wherein the distance between the first and second suction cup arrays is adjustable to accommodate different size sheets.

25 5. Apparatus according to claim 3 or claim 4 wherein the perfector comprises a shaft to which the arrays of suction cups are mounted.

6. Apparatus according to claim 5 wherein the first and second arrays of suction cups are respectively connected via first and second internal channels in the shaft to at least one vacuum system that controls aspiration of suction cups in the arrays.

30 7. Apparatus according to claim 6 wherein the first and second channels respectively have first and second orifices on the surface of the shaft and wherein the first orifice is displaced from the second orifice along the axis of the shaft.

8. Apparatus according to claim 7 and comprising first, second and third annular bearings mounted to the shaft, wherein each bearing has an inner and outer race that sandwiches a plurality of rollers and at least one seal between the inner and outer race.

5

9. Apparatus according to claim 8 wherein the first orifice is located between the first and second bearings and the second orifice is located between the second and third bearings.

10. Apparatus according to claim 9 and comprising a seal between the shaft and the inner
10 race of each bearing.

11. Apparatus according to claim 10 and comprising a housing mounted on the bearings, the housing having a housing wall formed with first and second through holes and having a cavity defined by a cavity surface, and wherein the first through hole is located between the
15 first and second bearings and the second through hole is located between the second and third bearings.

12. Apparatus according to claim 11 and comprising a seal between the outer race of each bearing and the cavity wall.

20

13. Apparatus according to claim 12 wherein the first and second through holes are connected to the at least one vacuum system via first and second pressure hoses respectively and wherein the suction cups of the first and second suction cup arrays aspirate when the at least one vacuum system respectively draws air through the first and second pressure hoses.

25

14. Apparatus according to any of claims 8-13, wherein the annular bearings are contact sealed bearings.

15. Apparatus according to any of claims 1-14 wherein the perfecter comprises at least one
30 sheet support surface on which the sheet lies when it is held by the perfecter.

16. Apparatus according to claim 15 and comprising a fan that creates airflow that presses the sheet flat to the at least one sheet support surface.

17. A dynamic seal for providing a gas seal between a shaft and a surface that enables the shaft to rotate with respect to the surface comprising:

a contact sealed bearing comprising rollers sandwiched between an inner race and an outer race and a seal between the inner and outer races that protects the rollers from dirt;

a gas seal between the inner race and the shaft; and

a gas seal between the outer race and the surface.

18. A sheet transport system for a printer that receives a sheet from an impression roller of the printer on which a first side of the sheet is printed referenced to a leading edge of the sheet and if the sheet is to be printed on its second side, turns the sheet over and returns the sheet to the impression roller, comprising:

a conveyor belt that feeds a sheet placed thereon to the impression roller;

a perfector that removes a sheet from the impression roller after a first side of the sheet is printed and if a second side of the sheet is to be printed, places the sheet on the conveyor belt, and if a second side is not to be printed, moves the sheet towards a printer output tray, the perfector comprising:

first and second brackets independently rotatable about a same axis;

a plurality of suction cups mounted on each of the first and second brackets;

at least one sheet support surface mounted on each bracket; and

a system that rotates the brackets sequentially, one after the other to remove printed sheets from the impression roller and either place a removed sheet on the conveyor or move the sheet towards the output tray.

19. A sheet transport system according to claim 18 wherein the at least one support surface mounted on a bracket is a relatively long narrow surface defined by a plane curve whose plane is perpendicular to the axis about which the first and second brackets rotate and wherein the radial distance from the axis to a point on the curve decreases as the distance of the point from the bracket increases.

20. A sheet transport system according to claim 19 wherein the at least one support surface of the first bracket is axially displaced from the at least one support surface of the second bracket.

5 21. A sheet transport system according to any of claims 18-20 and comprising a fan that creates airflow that presses a sheet placed on the conveyor belt to the conveyor belt surface.

22. An apparatus for transmitting vacuum to a device mounted on a rotating shaft comprising:

10 first and second annular bearings mounted to the shaft so that there is a space between the bearings, wherein each bearing has an inner race and an outer race that sandwich a plurality of rollers and at least one seal between the inner and outer races;

a seal between the inner race of each bearing and the shaft;

15 a housing having a housing wall formed with a through hole, said housing wall together with said bearings forming a cavity that surrounds the shaft and communicates with said through hole;

a seal between the housing wall and the outer race of each bearing;

wherein said shaft is formed with an internal channel having a first aperture that communicates with said cavity and a second aperture communicating with said device.

20

23. Apparatus according to claim 22 and comprising a source of vacuum that communicates with the through hole to produce a vacuum in the cavity and thereby to transmit vacuum to the device.

25 24. Apparatus according to claim 23 and comprising a third annular bearing that forms together with the second bearing and the housing wall an additional cavity that surrounds the shaft, wherein the bearing has an inner race and an outer race that sandwich a plurality of rollers and at least one seal between the inner and outer races.

30 25. Apparatus according to claim 24 and comprising a seal between the inner race of the third bearing and the shaft.

26. Apparatus according to claim 24 or claim 25 and comprising a seal between the outer race of the third bearing and the housing wall.

27. Apparatus according to any of claims 24-26 wherein the housing wall is formed with an additional through hole that communicates with the additional cavity.

28. Apparatus according to claim 27 wherein the shaft is formed with an additional internal channel that communicates with the additional cavity and with an additional device mounted to the shaft.

29. Apparatus according to claim 28 wherein the source of vacuum communicates with the through hole and the additional through hole to control vacuum in the cavity and the additional cavity independently of each other and thereby to independently control vacuum transmitted to the device and the additional device.

30. Apparatus according to any of claims 22-29 wherein at least one of the seals is an o-ring seal.

31. Apparatus according to any of claims 22-30 wherein the pressure attained in the vacuum transmitted to the device and the additional device is less than 0.03 atmospheres.

32. Apparatus according to any of claims 22-31 wherein the bearings are contact sealed bearings.

INTERNATIONAL SEARCH REPORT

International Application No

PCT/IL 00/00081

A. CLASSIFICATION OF SUBJECT MATTER
 IPC 7 B41F21/10 B41F13/00 F16L39/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 B41F B41J F16L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

PAJ, EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 196 35 388 A (KBA-PLANETA AG) 5 March 1998 (1998-03-05) the whole document ---	1
A	EP 0 312 660 A (KOMORI PRINTING MACHINERY CO. LTD.) 26 April 1989 (1989-04-26) column 8, line 29 - line 56; figures 3,4 ---	1
A	EP 0 311 924 A (KOENIG & BAUER AG) 19 April 1989 (1989-04-19) column 4, line 16 -column 5, line 28; figure 1 ---	1
A	EP 0 161 522 A (HEIDELBERGER DRUCKMASCHINEN AG.) 21 November 1985 (1985-11-21) page 6, line 8 - line 29; figure 1 --- -/--	1

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

13 September 2000

Date of mailing of the international search report

29.09.00

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DIAZ-MAROTO, V

INTERNATIONAL SEARCH REPORT

International Application No

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4 165 689 A (GIUIUZZA) 28 August 1979 (1979-08-28) the whole document ---	18
A	EP 0 435 164 A (M.A.N.-ROLAND DRUCKMASCHINEN AG.) 3 July 1991 (1991-07-03) the whole document ---	17,22
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A	US 4 202 268 A (BECKER) 13 May 1980 (1980-05-13) ---	
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/IL 00/00081

B x I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

B x II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☒ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☒ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. Claims: 1-16

Apparatus for duplex printing

2. Claims: 18-21

A sheet transport system

3. Claims: 17, 22-32

A dynamic seal and an apparatus for transmitting vacuum

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/IL 00/00081

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/IL 00/00081

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